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Professor T. Brailsford Robertson.

The death of Professor Brailsford Robertson* will come as a profound shock both to the scientific world as a whole, to his intimate friends, and to all those who were so happily associated with him during the last few years of his life, during which period, as Chief of the Division of Animal Nutrition of the Commonwealth Council for Scientific and Industrial Research, he undertook work of the greatest importance to the pastoral industry.

Thorburn Brailsford Robertson was born in Edinburgh in 1884 and came to Adelaide as a boy of ten. He was educated by tutors and at a private school in Glenelg, eventually proceeding to the Adelaide University, where he received his B.Sc. degree. Under the late Sir Edward Stirling (Professor of Physiology at the Adelaide University) he commenced those profound biological studies to which he devoted his life, and which have made his name famous throughout the scientific world. Shortly after he obtained his B.Sc. degree at Adelaide he proceeded to the University of California, where he was closely associated with the famous Jacques Loeb, during which period he gained his D.Sc. and Ph.D. degrees. The high opinion of Brailsford Robertson was confirmed by his appointment as Loeb's successor. In 1910 he married Jane Winifred Stirling, the daughter of the late Sir Edward Stirling, who had been the friend and mentor of his early days, and whom he succeeded in 1919.

Robertson was a tremendous worker; his published pamphlets number several hundreds, and his chief works, *The Physical Chemistry of the Proteins, The Principles of Biochemistry,* and *The Chemical Basis of Growth and Senescence,* are regarded as standard works, the first named having been translated into both German and Russian.

In February, 1927, he was asked to form the Division of Animal Nutrition of the Commonwealth Council for Scientific and Industrial Research, and, with the consent of the University of Adelaide, he was enabled to embark upon work which has proved of the utmost value to the pastoral industry. Moreover, he built up his Division on sure foundations. He was one of those rare characters who took his staff

* Professor Robertson died on the 18th January, 1930, from pneumonia supervening on influenza.

into his confidence, let them see what he was doing, and gave them an intimate knowledge of the problems in hand. In co-operation with the leading pastoralists and his staff, he has laid down a programme of work which will take many years to complete. He has organized a series of field-stations where experimental work has already been carried out, which is proving of the greatest importance, such as that dealing with the value of protein as a supplement to diet in drought-stricken areas; the value of a cystine-high diet in the production and quality of wool; the causes and treatment of "break" in wool; and a series of experiments on the values of various forms of phosphates as supplementary diet in phosphate-deficient country. In addition to this an extensive survey of the iodine content of thyroid glands of sheep is being carried on.

It was, however, not only in the realms of science that his greatness lay. He was a man whose gentleness of character endeared him to all and sundry. He possessed an infinite patience, and would drop his work and listen to the difficulties of others with the greatest sympathy and understanding. His interests were very wide; in plant and animal life, in art and literature and music he took the keenest interest, and his understanding of children and his love of them were two of his most endearing characteristics. His book for children, *The Universe and the Mayonnaise,* is a delightful illustration of this. His physical presence has gone, but he has left his influence deeply rooted in the hearts of those who knew and loved him. To quote Professor Kerr Grant: "The leader has passed away, but he has left behind him, not only a plan of operations, but a small body of ardent disciples trained in his methods and imbued with his spirit, who may be relied upon to carry on his work and make it an eternal monument to his memory."

J.W.W.

Marine Biology and Sea Fisheries Problems.

By William J. Dakin, D.Sc., F.Z.S., Professor of Zoology, University of Sydney.

Nothing has been more characteristic of the past forty years than the steady invasion of industry by science, and the more intense the invasion, the more difficult it has become to trace the boundary between so-called applied science and pure science. The application of biological science is still young, and it is only within comparatively recent years that the branches of biology have passed from the classificatory to the experimental stage. The application of biological science to agriculture is now everywhere appreciated; the application of biological science to sea fishery problems is not so widely understood, although the United States of America has set a very fine example and this may equally be said of several of the countries bordering the North Sea.

It becomes the duty of a Government to guard and protect the fishing resources so that depletion may not occur and that they may thus continue indefinitely to provide food. This means utilization to the fullest extent compatible with perpetuation. We may never be able to cultivate the sea fisheries as we can those of the fresh waters, but we can find possible ways of preserving them from destruction, utilizing them to better advantage, and possibly even predicting when and where profitable fisheries may be found.

Biological problems frequently offer extremely difficult tasks for their investigators. The factors involved in a problem may not only be exceedingly numerous, but irritatingly labile. This does not lessen interest in them but it does give a false impression to those who want an immediate result and do not realize the immense amount of patient investigation that may be involved. It would not be difficult to illustrate this by many examples in medicine, veterinary science, and agriculture. It applies with greater force to marine biology.

The world's fisheries and aquiculture rank with agriculture as an important branch of human industry, essential for the support of human existence. Without scientific development, their pursuit would be disastrous in these days of highly efficient fishing machinery, high wages, and high standard of living. This is not generally realized in Australia, but it has been fully appreciated by many countries, amongst which are small countries which could not afford to spend money on "frills."

The sea is not necessarily less productive than the land; in fact, certain areas of the sea have been shown to equal rich pastures. This is usually surprising at first to most people who fail to see anything comparable in the two. But the sea water supports a rich collection of floating life ranging in size from organisms needing a microscope to be visible at all to others easily seen with the naked eye. These creatures, plants, and animals, early stages and adults, a mixed assemblage whose only distinguishing feature is that its individuals float at the mercy of currents, are known collectively as plankton. There may be 200 diatoms to every drop of sea water, or several hundred millions under every square metre of surface; in fact, microscopic peridinians may be so abundant at times in the water of Sydney harbour that it becomes almost red in colour. On the other hand, the

ocean may be deep blue, very transparent, and then it is almost comparable to a desert. Now, the importance of the plankton (of which more below) lies in this: that with the exception of the seaweeds in shallow coastal waters, the microscopic plants of the plankton form the ultimate link between mineral matter and the animal life.

But the productivity of the sea is not everywhere the same. A considerable amount of scientific evidence has been brought forward to show that temperate and arctic seas produce more plankton than tropical waters. All the great fisheries of the world are in cold or temperate waters. The greatest whaling centres are in the colder seas. Various theories have been brought forward to explain this phenomenon, but there is still much to be done in confirming the supposed facts. If sea temperature is a determining factor, directly or indirectly, it must be a most important problem for those countries like Australia, whose fishery hopes lie partly in tropical or sub-tropical waters.

Notwithstanding the above facts, there has never been a published investigation of a series of quantitative plankton catches taken through a period lasting over a year in tropical or sub-tropical waters. The only catches of this type made in Australian waters have been those taken recently by the Barrier Reef Expedition and during the last year by myself off Port Jackson. One cannot carry on this kind of work without having the means of going out a little distance into ocean waters; and hence the need for a suitable boat.

The abundance of plankton in any sea area is now known to be linked up with the physical and chemical conditions of the sea water. The phosphate content, nitrate content, salinity, temperature, &c., are all factors of the greatest significance: and so the need arises for oceanographical surveys. Indeed, apart from the effects on the plankton, slight changes in the temperature of the sea have been known to cause extensive migrations of fish and other marine organisms. Intense cold in the North Sea area is often accompanied by a movement of fish to the deeper parts. Organized records of temperatures and chemical conditions often serve another end still, in enabling us to determine ocean currents and water movements of importance in the life-history of food fishes.

It might have been thought that fisheries investigations in Australia would, at present, consist in the search for fishing grounds, and the initiation of the scientific observations for an understanding of fisheries problems. Already, however, a problem has been put forward by the trawler owners of New South Wales, and it is interesting because this is the first commercial trawling region of Australia. Trawlers have not been at work for very long, yet it is stated that already, during the past year, there has been a very remarkable falling off in the catches. Indeed a demand for inquiry has already been sent out by the trawler companies. Allowing that the facts are correct, this may mean—

1. That the New South Wales grounds have already been over-fished and depletion has occurred.
2. That the chief fish species concerned has moved to other grounds in consequence of the trawling.
3. That the variation is of a natural order, is temporary, and is due to causes of which we have not the slightest idea, no records of any scientific sort being available.

It seems rather sudden for (1) to have taken place, and it would be a serious matter if it were the case. It might be suggested that the fish be looked for elsewhere. This would certainly be something, if they were found, but it would not necessarily permit us to distinguish between the possibilities mentioned above, nor enable us to legislate or arrange our programme for the future.

The abundance of fish in any region does not depend upon the conditions existing at that particular spot during the time that fishing is taking place, or even during the season in question. The fish which are of a commercially valuable size are probably two, three or more years of age. Several years earlier then, they were extruded from a female fish, fertilized in the sea, and probably floated to the surface as constituents of the plankton. (The eggs of most of the commercially important sea fish, herring excepted, are light and float during development; they are termed pelagic eggs). They will have joined that heterogeneous assemblage of plankton creatures floating with the ocean currents. It is possible in northern waters (thanks to biological research) to recognize the different fish eggs at this stage, and this supplies us with one method of determining spawning grounds. This piece of fundamental research still awaits attention here; it is hoped to make an attempt to investigate the eggs and larvae of the tiger flathead this year. The floating eggs eventually hatch into a tiny floating larval stage and the larvae continue in the plankton and feed upon it. By this time they may be miles and miles away from the place where the mother fish spawned. Obviously, the chances of survival of millions of these tiny creatures is going to be dependent upon a suitable supply of microscopic food being available for them, and suitable hydrographic conditions for both the food organisms and themselves.

We see, therefore, that an abnormal set of physical conditions at some area of the ocean may very seriously affect the fishing at quite a different place some years afterwards.

Eventually, the young larvae referred to above may move to the sea bottom (if we are dealing with a fish that lives on or near the bottom in the adult stages, like the flathead and flounder), but the sea bottom below them at this period of change of life may be quite unsuitable for their existence. Here is another risk to be overcome. Finally, supposing that all has gone well, a quite extensive migration may be necessary between this period and that when a commercial size and maturity have been attained.

I have stressed this case because it indicates complex factors involved, and it shows how a fish which may devour worms, small crustacea, shell-fish, or small fish in its adult life may depend upon the plankton during early stages. Fish like the herring or pilchard, which feed directly upon the plankton, naturally have their occurrence and their movements more obviously bound up with plankton conditions.

It will be clear that the life history of a fish must be known from the egg stage to the adult. Even if the information does not help us to increase directly the fish supply, it may prevent serious destruction. It was found, for example, that the young of the plaice, a North Sea fish, spent their early months in very shallow coastal water, and were in danger of being caught in vast numbers in prawn nets. In fact,

10,400 of them, only four inches long, were captured in ninety minutes. They were quite useless at this stage and the value of the prawns caught was negligible.

Knowledge of the migrations of fish is always of the utmost importance to the fishing industry, and here again there is a vast field for inquiry round our Australian coasts. Fish migration may be seasonable and of more or less constancy, or it may be irregular. There is generally a breeding and a feeding migration, the former being very characteristic of most marine organisms. We are told that the New South Wales trawlers have come to expect a heavy yield of flathead with ripe spawn off Botany Bay at a certain season (it seems to have been missing this season). From whence did these spawners come? It is not so easy to determine this (by merely catching fish at different points of the coast, for example) as one might casually assume. Fish have been considered as moving up a coast because ripe fish were caught successively later in the season as one went northwards.

Later, more scientific work showed that there was no such movement at all: the fish in this case had migrated inwards from deep to shallow water, but the movement had started earliest in the south and occurred gradually later as one went north.

If statistics show that more of a particular trawled species are caught year after year in one season than in others, it is pretty certain that a migratory habit is the explanation, other factors such as intensity of fishing, &c., remaining the same. Sometimes, however, a decline may extend over two or three years and then be followed by an increase again.

In order to investigate these problems, the system of marking fish whilst alive was applied by scientists of Europe. Suitable individuals, carefully captured, are quickly measured, &c., marked with some type of label fastened through the body, and set free. All fishing ports and trawlers of different countries are placarded, and a reward is offered for the return of such marked fish when captured—details of the place of capture being given. This not only enables migration routes to be observed, but gives information about the rate of growth.

Age determinations are of considerable importance in fishery investigations, especially in connexion with over-fishing problems. They may indicate too that a particular year's spawning has been exceptionally good and has been followed by several lean years. Such age determinations are very much required for Australian commercial fishes. The investigation will utilize various methods, such as the statistical treatment of series of samples of different sizes from different parts of the coast, examination of otoliths, and scales. Here again it is impossible to say what difficulties will be met. Rings of growth on scales sometimes give a quick indication of the age of a fish, once the proper interpretation of the rings has been worked out. But I am not aware that the method has been applied to any tropical or subtropical fish, and there has been much dispute about the interpretations of comparativly well known examples.

Only a few of the fundamental aspects of fisheries science can be mentioned here, and there is little space for reference to fish diseases, to the problems which have arisen where fish have been smoked, or preserved in other ways, to the important investigations of shell-fish

and crustacea, &c. Biological stations have even taken up the investigation of methods of preserving fishing nets (oleate of copper process), the development of new implements, and the problems of refrigeration.

The writer has heard the question in Australia—"What is the good of scientific investigation of the fisheries?" One might answer by pointing to the countries which are pursuing this more and more every year. Legislation is certainly indefensible without a scientific basis of fact. One is reminded of the British Government inquiry of 1878, on the Destruction of Fish Spawn by Trawl Nets, the participants in which were apparantly ignorant of the fact that Professor Sars and other workers had discovered the floating nature of most of the eggs 10 to 14 years before.

Marine biology and oceanography have now become specialist studies just like entomology and genetics. They have their own technique, ingenious apparatus, and already a vast literature. Special university departments and biological stations have been set up for marine investigations. We have some distance to go in Australia, for even pure zoology cannot do justice to the marine side without marine laboratories. Thus we shall undoubtedly be handicapped at the outset by the lack of trained workers. Australia has its own species of fish, and will naturally have its own problems, but the research methods to be applied will, in the first case, be those fundamental methods which have already stood a considerable test elsewhere. It is essential, therefore, that we should be well acquainted with the technique already developed.

To draw up an adequate and comprehensive programme for fisheries investigation for a country with Australia's extensive coastline is no easy task. The countries bordering the North Sea all participate in the investigation of their bordering seas, and so, at the same time and during several seasons each year, five or more large investigation vessels may be at work collecting data in that area. It would be impossible for one vessel to carry out the same type of investigation here, and other schemes must be evolved. It is essential, however, that in applied marine biology, effort should be concentrated and not dissipated by superficial touches here and there. This applies almost as much to the search for fishing grounds, that is, to the exploratory work necessary in the early development of sea fisheries. One of the first important needs in fisheries investigations is the collection of accurate statistics. Statistical inquiry plays a very great part when one is dealing with problems which may not lend themselves to experimentation. But statistics of the type meant here have never been taken in connexion with Australian fisheries, or at least are not in existence to-day.

It has been urged that an immediate "search" vessel is required in order to determine the fisheries resources of the coast of Australia. Fortunately, such a vessel, if properly equipped, at the same time and practically without additional costs would furnish the material for "research." By this I mean, that for "search" alone, it is necessary that the catches obtained be properly analysed and reports prepared for statistical research. A mere statement of the number of pounds of fish caught at a certain place in a certain time is not enough. And whilst the vessel is at a trawling station, there is nothing to prevent the recording of temperature observations, the collection of water samples for analyses on land, or the capture of plankton.

For more immediate work still, or for small and special explorations, it is possible to adopt the method recently put in practice in England, where a good trawler was sent out to investigate a new ground, and the difference between the net cost of the voyages (two) and the sum obtained from the captured fish was divided between a fishing vessel owners' association and the Government.

Flying Fox Investigations.

By F. N. Ratcliffe, B.A.

Mr. Ratcliffe is the investigator appointed to investigate the flying-fox problem under the co-operative scheme of work entered into by the Council and the State Departments of Agriculture in New South Wales and Queensland (see this *Journal*, Vol. 2, No. 4, p. 58). He has now been pursuing his inquiries for some nine months. The specific purpose for which he was appointed was to make a biological study of those species of flying foxes which are a pest in Australia, as a preliminary to the formulation of a programme of research aimed at the development of methods of control. He has now furnished the following article descriptive of the habits, &c., of certain varieties.—Ed.

1. General.

The term flying fox is used in Australia to include at least four species of "Fruit Bats" (Megachiroptera) of the genus *Pteropus.* Three of these species are peculiar to this Continent, which fact alone indicates that the animals are by no means recent additions to the Australian fauna.

The flying fox presents a problem of a rather common type (particularly among birds): that of an animal natural to a country, whose wide range and varied diet enables it to become an economic pest of certain cultivated crops. The food of flying foxes includes most fruits with a pretence to succulence, and the nectar-bearing blossoms of such genera as *Eucalyptus, Eugenia, Melaleuca,* &c. In times of drought and general food shortage, they have been reported to eat the young bark and buds of forest trees, the cobs of ripening maize, and also pineapples and other fruits which are normally untouched owing to the nature of their growth. It is in such "poor" seasons that the greatest damage is done among the orchards and plantations.

The distribution of flying foxes appears to be limited by the following factors:—(1) food supply; (2) temperature; and (3) the occurrence of patches of dense vegetation in which the animals can "camp" in the day time. A further factor, the presence of water, may be important, particularly in open forest regions where the nectar of blossom must supply the principal, if not the only food.

The ranges of the four common* species of flying fox are approximately as follows:—

Pt. conspicillatus.—New Guinea, the Cape York Peninsula, and south at least to Cardwell.

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* A fifth species, *Pt. brunneus*, has been recorded once, from the Percy Islands.

Pt. Gouldi.—The coasts of North-West Australia, the Northern Territory, Cape York Peninsula, and the east coast extending south at least to the Burnett River.

Pt. scapulatus.—Similar to *Pt. Gouldi,* but extending further south, occasionally even to southern New South Wales.

Pt. poliocephalus.—East coastal regions from Central Queensland (Rockhampton) to Southern New South Wales, occasionally Victoria, and possibly even Tasmania; also inland to Dalby (Queensland) and the Northern Tableland of New South Wales.

During the summer months, flying foxes (*Pt. Gouldi* and/or *Pt. scapulatus*) occur inland in North-western Queensland in the neighbourhood of the rivers, presumably having followed their courses from the Gulf of Carpentaria for the blossoming of the eucalypts and ti-trees. Thus they are found regularly in the Cloncurry district, often in considerable numbers.

2. Camps and Numbers.

Perhaps the best known peculiarity of flying foxes is their habit of congregating in large "camps" during the daytime. These camps are almost always in patches of dense tropical scrub (or "brush," to use the New South Wales term), or alternatively in mangrove swamps. Although each of the different species may camp either in mangroves or inland scrub, *Pt. Gouldi* seems to prefer the former, *poliocephalus* and *scapulatus* the latter site.

In an area within the range of more than one species, the camps may be mixed. For instance, in an inland scrub near Rockhampton, *Pt. Gouldi, poliocephalus,* and *scapulatus* occurred together. The different species tend to segregate in different parts of the camp, as do the two sexes of one species, particularly when the females are pregnant or carrying newly-born young. In this case the desire for peace is presumably the reason for their seclusion, as a camp is very rarely quiet, the animals squabbling and crying out almost incessantly.

It is extremely difficult to estimate the number of individuals in a camp. Merely to walk through it seems to provide no idea of the real numbers present, for the flock that leaves at nightfall is always surprisingly large. Counting on the wing is usually not effective, as apart from the extreme difficulty of the process, more than one stream will as a rule leave a camp, each taking a different direction.

A large camp in Central or Northern Queensland must contain hundreds of thousands of individuals; and it is possible that in "peak" years the number may run into millions. In the camp near Rockhampton mentioned above, the foxes were distributed, not at all thickly, through some 10 or 12 acres of tall scrub. The breaking up at sundown took over 30 minutes, during which time the main column, quite 200 yards wide, and possibly 100 feet deep, continued to fly away from the treetops in undiminished intensity. When a flight of this size passes overhead the sky seems literally to be darkened, and sometimes the air may be filled with the unpleasant, musky smell of their bodies.

Pt. scapulatus seems to form the largest camps. One in the mangroves at the mouth of the Burnett River covered an area estimated to be nearly one-eighth of a square mile (80 acres). The animals were hanging so thickly that 60 were secured with half a dozen shots. An

informant from the Gulf of Carpentaria has described a camp 4 miles long and a quarter of a mile in width. It is obviously quite impossible to arrive at even a rough approximation of the numbers in these exceptionally large camps.

It is more easy to estimate the number of camps in an area than the number of individuals a camp may contain. Thus within a 20-mile radius of the city of Rockhampton there are probably over half a dozen large camps in normal years. It may be said, without fear of exaggeration, that along the eastern coast from the mouth of the Burnett River northward there are large camps at average intervals of 30 miles or less. Three, four, or more such camps may even occur in some districts (e.g., near Townsville, Northern Queensland) along a 30-mile stretch of coast. In addition to these coastal camps (usually in the mangroves at the mouths of the numerous rivers and creeks) there are probably at least as many, or even more, in the inland scrubs along the coastal belt.

There appears to have been a general decrease in the number of flying foxes (*Pt. Gouldi* and *poliocephalus*) during the last five or six years. A large number of the Southern Queensland camps have disappeared, and the remainder are not nearly as large as formerly. In the north generally, the huge evening flights have not been noticeable of late years, and certain "permanent" camps seem to have become seasonal. On the other hand, *Pt. scapulatus* appears to be on the increase at the present time. They appeared in large numbers in Southern Queensland during November, 1929, a rather unusual occurrence. With two exceptions (both very small camps), every camp visited in Central Queensland during the latter part of the year contained *Pt. scapulatus* either alone or in marked preponderance.

3. Breeding.

Flying foxes are placental mammals. Normally, only one is born at a time, though twins have been reported. There is a well-marked breeding season. In the case of *Pt. Gouldi* and *poliocephalus* the young are born in October, or thereabouts, whereas *Pt. scapulatus* is mating during this month. (No observations have been made in the case of *Pt. conspicillatus.*)

The numbers of the sexes appear to be approximately equal, though this equality is often masked by the segregation, partial or complete, of the sexes, which seems to take place after the mating season.

The young are the size of a large mouse at birth, and are carried clinging to the breast of the mother until old enough to fly. When too large to be carried easily, the mother will leave the young one hanging in a tree, and bring it fruit periodically.

4. Migration.

All the species seem to be migratory to some extent, mobs continually shifting from place to place in search of food. Thus the larger camps will fluctuate in size throughout the year, while smaller camps will be formed and abandoned in suitable localities. In addition to these "local" movements, *Pt. poliocephalus* (and *scapulatus* to a somewhat lesser extent) carries out regular and extensive seasonal migrations, moving southward in mass in the early summer, and returning north again when winter approaches. Thus flying foxes only occur normally

in Southern Queensland (south of Gympie) and New South Wales between the months of October and April. During this southern migration, the same camping sites will be inhabited year after year.

5. Feeding.

Blossom seems to be the most important single item in the diet of flying foxes. *Pt. scapulatus* is almost exclusively a blossom feeder, in fact in certain localities it is known as the "brown honey fox." Of the other two common species, *Pt. Gouldi* seems to depend more on blossoms for food, though *Pt. poliocephalus* forms temporary camps in certain localities during the flowering periods of ti-trees (*Melaleuca* sp.). There are indications that these two species, and even the different sexes of each species, have somewhat different food preferences. For instance, observations made by a fruit-grower in the Burnett district, extending over several years, show that all the foxes shot in the orange trees were pregnant females of *Pt. Gouldi,* while the non-citrus fruit was being attacked solely by males of *Pt. poliocephalus.*

In Queensland, generally speaking, native fruits are usually available in plenty, even in seasons when there is little blossom, the scrubs, in particular, providing a large crop of wild figs of various species. Citrus fruit and bananas (which, with pineapples, form the bulk of the State's commercial fruit crop) are not as a rule seriously attacked. The mango crop, however, suffers very heavily, though this is of no great commercial value.

New South Wales, together with the Stanhope district of Queensland, provide a different set of conditions. Here the fruits cultivated (stone fruits, apples, pears, quinces, &c.) are more to the foxes' taste than are citrus and bananas. Furthermore, most of the patches of scrub are being cleared, which probably has the immediate effect of driving an increasing number of foxes to seek food in the orchards. Altogether, although the animals are relatively much less numerous, they are probably a greater economic pest here than they are in the north.

There is no doubt that, even in the southern districts, only a small proportion of the total number of flying foxes engage in the orchard raids. In North and Central Queensland, the proportion must be very small indeed; but owing to their large appetites, and particularly to their habit of damaging more fruit than they actually eat, comparatively small numbers of foxes can cause heavy losses.

Unfortunately, the flying foxes' mode of feeding, and the rapidity of their digestive process, renders stomach examinations (even if carried out in the early hours of the morning, as soon as the animals return to their camps) almost useless in the elucidation of the details of their dietary.

6. Natural Enemies.

The only animals actually observed by the investigator to prey on flying foxes are the wedge-tailed eagle, and a species of monitor lizard ("goanna"). A pair of the former were seen rounding up a camp of foxes near Bundaberg, and a large specimen of the latter was killed in a camp near Rockhampton, which on subsequent examination was found to contain the partly digested bodies of two embryo foxes, with the placentae still attached. Carpet snakes (*Python spilotes*) occur

frequently in flying fox camps, and undoubtedly account for a large number. Probably many of the larger birds of prey attack flying foxes. A pair of white-breasted sea eagles nested on the edge of a camp near Grafton, New South Wales, and the ground below their nest is said to have been strewn with the bones of flying foxes. In the north of Queensland, the fresh-water crocodile (*C. Johnstoni*) takes heavy toll of flying foxes, snapping them up as they fly down to the surface of water holes to drink.

Some Australian Poison Plants—Amounts Fatal to Sheep.

The following two papers have been furnished by the Poison Plants Committee (see this *Journal*, Vol. 1, No. 1, p. 56).—Ed.

PAPER 1.

The Lethal Dose of Hydrocyanic Acid for Ruminants.

By W. L. Hindmarsh, B.V.Sc., M.R.C.V.S.

In the course of certain investigational work in connexion with cyanogenetic plants, it was found necessary to ascertain accurately the lethal dose of hydrocyanic acid for ruminants. References in veterinary literature to the fatal dose of this drug are indefinite. Thus Finlay Dunn (1) states that full doses kill almost instantaneously by cardiac arrest or somewhat less suddenly by respiratory arrest, but no mention is made of the dose required to produce death in ruminants. Lander (2) states that a heifer (size or age not indicated) withstood 22.5 grams of pure acid given as potassium cyanide, but was killed by oral administration of 30 grams. Petrie (3) says the lethal amount of hydrocyanic acid is usually stated as 1 mgm. per kilogram of body weight, but his authority for this statement does not appear to be quoted. Ramsay (4) gives a table dealing with the hydrocyanic acid content of sorghum-sudan grass hybrids, and states that a plant containing 0.003 per centum of prussic acid (0.210 grains per pound) would contain the minimum fatal dose of hydrocyanic acid for a sheep in 4.41 lb. of the plant. It is understood that these figures are based upon the ratios quoted by Petrie above.

Auld (5) has apparently determined the lethal dose of hydrocyanic acid for sheep, using potassium cyanide, but we have not as yet been able to consult his work, and do not know what lethal dose was arrived at by him.

A series of experiments was carried out at this Station* with the object of determining definitely the minimum lethal dose of prussic acid computed in terms of the body weight. The drug used was standardized and filled into glass ampoules for the experiments by arrangement with Mr. H. Finnemore, B.Sc., of Sydney University.

* The Glenfield Veterinary Research Station of the New South Wales Department of Agriculture.

The results of these experiments are shown in the following table:—

Sheep.

Weight of Sheep in lb.	Dose Rate per 1 lb. Body Weight.	Amount Given.	Method of Administration.	Result.
79	0·5 m.g.	39·5 m.g.	Intraperitoneal ..	Symptoms of poisoning Recovery
79	0·75 ,,	59·25 ,,	,, ..	,, ,,
53	1·0 ,,	53·0 ,,	,, ..	Death in 15 minutes
35	1·0 ,,	35·0 ,,	,, ..	Death in 40 minutes
57	1·0 ,,	1·42 cc. Scheele's acid	,, ..	Death in 18 minutes
150	0·6 ,,	*90·0 m.g.	Intrathoracic ..	Death
34·5	1·0 ,,	34·5 ,,	*Per os.* ..	Symptoms.† Lived 48 minutes
43	0·64 ,,	*28·0 ,,	,, ..	Symptoms of poisoning Recovery
86	1·0 ,,	86·0 ,,	,, ..	Death in 23 minutes

* Given in two doses.
† Killed after 48 minutes in connexion with another experiment.

From the above, it appears that hydrocyanic acid administered by intraperitoneal injection is lethal if administered to sheep at the dose rate of 1 milligram per 1 lb. body weight. By intrathoracic injection, hydrocyanic acid was fatal in one case at a dose rate of 0.6 milligram per 1 lb. body weight. Given *per os* the lethal dose rate of hydrocyanic acid appears to be in the vicinity of 1 milligram per 1 lb. body weight.

Cattle.

Weight.	Dose Rate per 1 lb. Body Weight.	Amount Given.	Method of Administration.	Result.
560	1.0 m.g.	14 cc. of Scheele's acid	Intraperitoneal injection	Grave symptoms, lasting 155 minutes, but followed by recovery

It appears from this one experiment that hydrocyanic acid given intraperitoneally at the rate of 1 milligram per 1 lb. body weight is highly toxic and nearly lethal for the cow.

References Cited.

(1) Finlay Dunn, Veterinary Medicines, 12th edition, p. 429.

(2) G. D. Lander, Veterinary Toxicology, 2nd edition, p. 97.

(3) J. M. Petrie, *Proc. Linn. Soc. of New South Wales,* **45**, pt. 3, p. 447.

(4) A. A. Ramsay, *Agric. Gaz., New South Wales,* **40** (1929), p. 735.

(5) S. J. M. Auld, *Jour. Agric. Sc.*, **5** (1912-13), p. 409.

PAPER 2.

The Fatal Dose for Sheep of Cyanogenetic Plants containing Sambunigrin or Prunasin.

By H. R. Seddon, D.V.Sc., and R. O. C. King, B.V.Sc.

In the State of New South Wales, cyanogenetic plants are a not uncommon cause of death of stock, but though certain plants are known to be so toxic at times as to cause death, the fact that at other times they may be eaten with impunity is also well established.

Two factors seem to be concerned here, namely:—

(*a*) Variation in susceptibility of stock; and

(*b*) Variation in cyanogenetic content of the plant concerned.

1. Variation of Susceptibility of Stock.

It is known that cyanogenetic plants are especially dangerous for hungry, even more so for starving, stock, and hence one finds that the greatest losses are experienced in stock travelled over comparatively bare stock routes, or in stock which have been de-trucked and then suddenly allowed access to the plant. Stock of either type coming upon a profuse growth of cyanogenetic herbage commonly eat greedily, and in a matter of an hour, perhaps less, show symptoms of HCN (prussic acid) poisoning. Such may occur in a paddock wherein other stock are grazing, though no losses are experienced in such local stock. This is to be ascribed to the fact that hungry stock will commonly eat plants which well-fed stock will eat to a limited extent only, if at all. If eaten by such local stock, it is usually at a rate much slower than that of the hungry stock, and one assumes that the rate of elimination of the hydrocyanic acid produced by the fodder equals the rate of absorption. In other words, there is not at any particular time a lethal (or even a toxic) dose of free HCN within the animal.

Though, at times, losses in stock under the circumstances above mentioned may be due to tympanites (hoven), yet at other times the quantity of fodder eaten, the symptoms shown by sick animals, and the rapidity of death, are such that, together with the result of chemical analysis of the plant concerned, there is no question but that HCN poisoning has been responsible for much mortality.

Whilst in western areas, HCN poisoning is seen almost solely in hungry or starving stock, it is well to remember that in the case of some plants the cyanogenetic content is so great, or the liberation of the HCN so rapid, that in some cases it is not necessary for the stock to be in this extremely hungry state. This is the case with sorghum poisoning, for if stock be allowed access to the young growing plant, or the same be cut and given fresh to stock (commonly dairy cattle), serious results are likely to result whether the animals are hungry or not.

2. Variation in Cyanogenetic Content.

Most of the records ascribing cyanogenetic properties to plants have been following qualitative examinations only, though the degree of cyanogenesis has often been expressed from the fact that the test

employed has resulted in a "feebly" or "strongly" positive reaction for HCN. In some instances, however, quantitative estimations have been given, and from this evidence it has at times been deduced that a certain named quantity of the plant would constitute a fatal dose.

Among the analytical results which have been published, we find those given in the following table:—

Plant.	Per cent. HCN in— Fresh Leaves.	Air-dried Leaves.	Authority.
Acacia glaucescens	..	0·22	Finnemore and Cox (1)
" "	0·12	0·32 (calc.)	" "
" "	0·20	0·37 (calc.)	" "
" "	0·21	0·41	" "
" "	0·08	0·12	" "
Euphorbia Drummondii	0·033	0·085 (calc.)	" "
" "	0·036	0·103 (calc.)	" "
" "	0·066	0·086 (calc.)	" "
" "	0·058	0·077 (calc.)	" "
" "	0·055	0·099	" "
" "	0·053	0·091	" "
" "	0·039	0·041 (calc.)	" "
" "	0·046	0·059 (calc.)	" "
Goodia lotifolia	0·23	0·57 (calc.)	" "
Poranthera microphylla	0·018	0·051	" "
Eucalyptus corynocalyx	..	0·179	" "
Heterodendron oleaefolia	..	0·328	Petrie (2)
Acacia glaucescens	..	0·184	*
Eremophila maculata (Queensland)..	..	0·824	S.N. 5231*
Eremophila maculata (leaves only) (N.S.W.)	..	0·140	S.N. 5433*
Eremophila maculata (flowers only) (N.S.W.)	..	0·074	S.N. 5433*

* Analysis kindly supplied by Mr. Finnemore.

A perusal of the above table indicates that the cyanogenetic content may vary considerably. The figures for the air-dried plant are the more important for our further argument, inasmuch as some of the "fresh" specimens were not examined in the truly fresh state, and had consequently lost considerable moisture—a fact brought out in the table as published by the authors quoted.

3. Liberation of HCN from Cyanogenetic Plants.

It has been mentioned earlier that young growing or freshly cut sorghum may be toxic for cattle; the same plant, when cut and allowed to wilt rapidly, becomes harmless owing to rapid escape of HCN. But in many plants, as evidenced by the fact that, on analysis of the air-dried specimen, the amount of HCN may equal the amount calculated to be present after drying, we find that the cyanogenetic glucoside is quite stable. There are other plants, however, in which the glucoside is relatively instable.

For the liberation of HCN from the stable glucosides, it is necessary, of course, for the glucoside to be split by an appropriate enzyme, and as it has been shown by Petrie that an enzyme may be, and we have found it is commonly, present in other (non-cyanogenetic) plants

eaten by stock, any absence of, or deficiency in, ferment in the cyanogenetic plant is, under ordinary conditions, relatively unimportant. Our experiments with sheep which have been depastured on grasses or other herbage, shows that even though a cyanogenetic plant be deficient in enzyme, the ingestion of the plant may be attended with fatal effects. It is evident, therefore, that enzyme is commonly present in the rumen contents of normally-fed sheep.

But it would appear that the amount of enzyme present in different plants and plant products may vary considerably and, for the optimum evolution of HCN, adequate enzyme must be present in the fodder. We understand that the most fruitful source of the appropriate enzyme is the sweet almond.

A simple test will show that if a plant containing a cyanogenetic glucoside, but practically no enzyme, be taken and unit quantities of this placed with decreasing quantities of enzyme (sweet almonds), the liberation of HCN is more rapid with the larger quantities of enzyme. With the smaller quantities of enzyme the HCN is liberated (as judged by the effect on a test paper) at a much slower rate indeed.

4. The Fatal Dose of a Cyanogenetic Plant.

From the above it will be seen that, to determine the quantity of a cyanogenetic plant that constitutes a fatal dose, one must take into effect the following factors, viz.:—

(*a*) The fatal dose of HCN.
(*b*) The amount of cyanogenetic glucoside present in the plant.
(*c*) The amount of enzyme present.

To these might, perhaps, be added the susceptibility of the animal, but as our observations have been made on animals which have been continually pasture fed, they may be regarded as uniform in that respect.

The information hitherto available as to the fatal dose of HCN for sheep has not, we consider, been such that one could state definitely the minimal fatal dose of any particular plant, and it was, therefore, with the aim of obtaining adequate information upon that phase of the question that the investigations detailed by our colleague, W. L. Hindmarsh, in the preceding paper were undertaken. These have shown that, given by the mouth, the minimal fatal dose of HCN for sheep is 1 milligram per lb. body weight. For cattle, the dose is apparently about the same.

The minimal toxic dose is about 0.5 mgm. per lb. body weight, and thus we see that there is relatively little difference between the minimal lethal and minimal toxic doses.

Figures have been given above for the HCN content of various cyanogenetic plants, and these will be used to illustrate this paper. In our experiments about to be detailed, we used a specimen of *Acacia glaucescens,* which was kindly examined for us by Mr. Finnemore and Mr. Cox, and which gave a HCN content, as expressed on the air-dried leaves, of 0.184 per cent., and a specimen of *Eremophila maculata* from Mr. Finnemore, also air-dried, and of which the HCN content was 0.824 per cent.

Both these specimens were relatively deficient in enzyme, and as we wished to use enzyme in sufficient quantity, sweet almonds were employed for this purpose. Our aim was to have enzyme in such amount as to give the maximal liberation of HCN. In the absence of any definite method of estimating enzyme, we employed almonds at the rate of 0.1 gm. almonds to 1 gm. of plant. The almonds were crushed up and then ground into an emulsion with water.

5. The Minimal Fatal Dose of Cyanogenetic Plants for Sheep.

In conducting the following tests, the dried plant (which had previously been finely divided) was rubbed up with water, thoroughly mixed with a sufficient quantity and administered as a drench, a little water being added if necessary to wash out the bottle and ensure that the whole of the plant was administered.

The almond suspension was then administered immediately.

A.—*Experiments with Acacia glaucescens.*

Experiment 1—

Sheep No. 494.—Weight 94 lb.

Plant.—*Acacia glaucescens,* 94 gms. (i.e., 1 gm. per lb. body weight) in 800 cc. water.

Enzyme.—9.4 gms. almonds in 4 oz. water.

Result.—Sheep showed symptoms of HCN poisoning in 25 minutes, and death occurred in 45 minutes.

Experiment 2—

Sheep No. 483.—Weight 102 lb.

Plant.—*Acacia glaucescens,* 34 gms. (i.e., one-third of a gm. per lb. body weight) in 300 cc. water.

Enzyme.—3.4 gms. almonds in 3 oz. water.

Result.—Sheep showed slight symptoms after 45 minutes, but showed no marked symptoms, though observed for three hours.

Experiment 3—

Sheep No. 487.—Weight 103 lb.

Plant.—*Acacia glaucescens,* 68.6 gms. (i.e., two-thirds of a gm. of plant per lb. body weight) in 500 cc. water.

Enzyme.—6.86 gms. almonds in 4 oz. water.

Result.—Sheep showed symptoms of HCN poisoning in 15 minutes, and died in 55 minutes.

Discussion on the above Three Experiments.

At the time the above three experiments were undertaken, the HCN content of the plant was not known, and the tests were conducted with the idea of determining the minimal fatal dose of plant, and then calculating from that the minimal fatal dose of the cyanogenetic glucoside in question.

The following table enables one to compare the essential data from the above experiments :—

Expt.	Gms. of Plant.	Total HCN (in mgms.).	HCN per lb. Body Weight (in mgms.).	Result.
1	94·0	172·9	1·84	Death—45 minutes
2	34·0	62·56	0·613	Symptoms—recovery
3	68·6	126·0	1·22	Death—55 minutes

It will thus be seen that dried *Acacia glaucescens,* provided adequate enzyme is present, is fatal when the available hydrocyanic acid of the administered plant is 1.22 mgms. per lb. body weight of the sheep. Given at the rate of 0.613 mgms., the plant was only slightly toxic.

The investigations by Hindmarsh in the previous paper have shown that the fatal dose of HCN administered orally is 1 mgm. per lb. body weight. The above figure is slightly in excess of that, but is certainly not the possible minimum since the only small dose administered was at the rate of 0.613 mgms. HCN. It was, therefore, decided, as the HCN content of the plant was now known, to give it at exactly 1 mgm. per lb. body weight. This was done in the following experiments :—

Experiment 4—

Sheep No. 584.—Weight 71.5 lb.

Plant.—*Acacia glaucescens,* 38.85 gms., in 400 cc. water.

Enzyme.—4 gms. almonds in 4 oz. water.

Result.—Sheep showed symptoms in 10 minutes, and death occurred in 50 minutes.

As the HCN content of the plant administered was 71.5 mgms., the plant was administered at a rate equal to 1 mgm. HCN per lb. body weight.

Conclusion from above Experiment.

The administration of a cyanogenetic glucoside (in air-dried plant), at such a rate that the HCN content is equal to the minimal fatal dose of HCN itself, is attended with fatal results, provided the amount of enzyme available in the animal is adequate to hydrolyse the glucoside rapidly.

B.—*Experiments with Eremophila maculata.*

The following experiments were undertaken with the air-dried plant :—

Experiment 5—

Sheep No. 428.—Weight 70.5 lb.

Plant.—*Eremophila maculata,* 12.831 gms. in 250 cc. water.

Enzyme.—2 gms. almonds in 2 oz. water.

Result.—Sheep showed symptoms in 3 minutes, and death occurred in 33 minutes.

Experiment 6—

Sheep No. 420.—Weight 69.75 lb.

Plant.—*Eremophila maculata,* 4.244 gms. in 200 cc. water.

Enzyme.—1.0 gm. almonds in 2 oz. water.

Result.—Sheep showed symptoms in 10 minutes, but recovered in 1¾ hours.

Experiment 7—

Sheep No. 493.—Weight 86 lb.

Plant.—*Eremophila maculata,* 10.44 gms. in 200 cc. water.

Enzyme.—1.5 gms. almonds in 2 oz. water.

Result.—Sheep showed symptoms in 5 minutes, and death occurred in 50 minutes.

The results of the above three experiments, and also of Experiment 4, are given in the following table, which showed the HCN content of the plant administered.

Expt.	Plant.	Gms. of Plant.	Total HCN (mgms.).	HCN per lb. Body Weight (mgms.).	Result.
4	*A. glaucescens* ..	38·85	71·5	1·0	Death in 50 minutes
5	*E. maculata* ..	12·831	105·7	1·5	Death in 33 minutes
6	,, ..	4·244	35·39	0·5	Symptoms in 10 minutes Recovery in 1¾ hours
7	,, ..	10·44	85·696	1·0	Death in 50 minutes

Conclusion from Experiments with Eremophila maculata.

From the results obtained, it will be seen that this plant, like *Acacia glaucescens,* is fatal when administered at such a rate that the available hydrocyanic acid is equal to 1 mgm. per lb. body weight, provided that enzyme in sufficient quantity is available.

C.—*Experiments with Isolated Cyanogenetic Glucoside, Sambunigrin.*

Through the courtesy of Mr. Finnemore, we have been able to test the cyanogenetic glucoside (sambunigrin) isolated from *Acacia glaucescens.* Chemical analysis of this had shown that 1 gm. on hydrolysis was estimated to yield 92 mgms. of HCN. The glucoside in *Eremophila maculata* has been found to be prunasin.

Experiment 8—

Sheep No. 561.—Weight 62 lb.

Sambunigrin.—1.354 gms. in 150 cc. water.

Enzyme.—7.0 gms. almonds in 4 oz. water. (The quantity of almonds was at the same rate as had been given in Experiments 1 to 4, and was equal to about 1 gm. of almonds to each 18 mgms. of HCN content of glucoside.)

Result.—Sheep showed symptoms in 35 minutes, but death did not occur until 1 hour 50 minutes after administration of drenches.

Experiment 9—

Sheep No. 503.—Weight 119 lb.
Sambunigrin.—1.302 gms. in 150 cc. water.
Enzyme.—6.5 gms. almonds in 4 oz. water.
Result.—Slight symptoms in 12 minutes, passing off, and 2 hours later sheep quite normal.

The following table shows the essential date from the above:—

Table D.

Expt.	Sambunigrin (gms.).	Total HCN Content (mgms.).	HCN per lb. Body Weight (mgms.).	Result.
8	1·354	124	2·0	Died in 1 hour 50 minutes
9	1·302	119·25	1·0	Symptoms—12 minutes Recovery—2 hours

Conclusions from Experiments with Sambunigrin.

From the above, it will be seen that, provided enzyme is present in quantity, small quantities of the isolated glucoside are fatal, but the minimal fatal dose per lb. body weight would appear to be greater than one would expect from the HCN content, i.e., whereas free HCN or glucoside in plants are fatal in doses equivalent to an HCN content of 1 mgm. per lb. body weight, the isolated glucoside given at the rate of 1 mgm. led to mild symptoms only, followed by recovery, and at a dose rate of 2 mgms. led to death only after a much longer interval than was the case with the plant itself, or with free HCN at half the dose rate. The results do not appear to be due to idiosyncrasy of the experimental animals, and it would appear possible that the isolated glucoside is not hydrolyzed so readily as the natural glucoside.

6. The Content of HCN that Renders a Plant Potentially Poisonous.

To arrive at such a figure, one must have two other data, viz., the weight of the sheep, and the amount of the plant likely to be ingested.

The amount of green fodder eaten by sheep in, say, one hour, will naturally vary with the hunger of the animal and with the palatability of the foodstuff. Observations with several sheep have shown that within the time mentioned they may, if in good appetite but not hungry from prolonged deprivation of food, eat about 1 lb. of greenstuff, say 500 gms. For the purpose of our calculation, the weight of a sheep may be taken as 100 lb.

For sheep, therefore, the percentage of HCN to be regarded as dangerous in a cyanogenetic plant may accordingly be obtained from the following calculation:—

(*a*) $$\frac{\text{Weight of sheep (pounds)}}{\text{Amount eaten by sheep (gms.)} \times 10} = \text{per cent. HCN which is lethal}$$

e.g., for an average sheep—

$$\frac{100}{500 \times 10} = \frac{1}{50} = 0{\cdot}02 \text{ per cent.}$$

Conversely, if the HCN content of the plant be known, the minimal fatal dose for sheep may be ascertained from the following, the answer being in grammes of plant.

(*b*) $$\frac{\text{Weight of sheep (pounds)}}{\text{percentage HCN} \times 10} = \text{Minimal lethal dose of plant}$$

e.g., for an average sheep receiving a plant containing 0.02 per cent. HCN the result would be

$$\frac{100}{0 \cdot 02 \times 10} = \frac{100}{0 \cdot 2} = 500 \text{ gms.}$$

Taking the figures given in Experiment 4 (quoted above) we find :—

Weight of sheep, 71·5 lb.
Amount eaten by sheep, 38·85 gms.

Therefore, applying formula (*a*) we get

$$\frac{71 \cdot 5}{38 \cdot 85 \times 10} = \frac{71 \cdot 5}{388 \cdot 5} = 0 \cdot 184 \text{ per cent. HCN.}$$

Similarly, from Experiment 7, applying formula (*b*) we get

$$\frac{86}{0 \cdot 823 \times 10} = \frac{86}{8 \cdot 24} \doteqdot 10 \cdot 44 \text{ gms.}$$

The analysis being for the air-dried plant, the figure obtained will be of air-dried plant.

In all the above experiments, the *air-dried* plant was used. The moisture content of cyanogenetic plants varied fairly considerably, but is in the nature of 40 per cent. to 70 per cent. (*Acacia glaucescens* (leaves), 52 per cent.; *Eremophila maculata* (leaves), 52 per cent.; (flowers), 65.5 per cent.

If we assume that a sheep may eat 500 gms. of plant within an hour, and take the average weight of such an animal as 100 lb., we find that the minimal HCN content, per cent., which is to be regarded as dangerous is, as stated above, 0.02 per cent. of the fresh plant. The equivalent amount of air-dried plant would be 200 to 300 gms. of plant, but in view of the dry nature of the fodder, it is probable that not more than 200 gms. would be eaten. Assuming this to be so, we find that the minimal HCN content, per cent., which is to be regarded as dangerous, in the air-dried plant, and assuming the plant were eaten in that condition, would be—

$$\frac{100}{200 \times 10} \doteqdot \frac{100}{2000} \doteqdot \frac{1}{20} \doteqdot 0 \cdot 05 \text{ per cent.}$$

These two figures may, therefore, on theoretical grounds, be considered as figures which if found on analysis constitute potentially fatal cyanogenetic plants. The figures are :—

For fresh plant, 0.2 per cent. HCN ; for air-dried plant, 0.05 per cent. HCN.

If the HCN content be higher, the quantity necessary to be eaten will naturally be less than 500 gms., and we may, therefore, construct the following table, remembering that the result depends upon the presence of adequate emulsin.

Table of Toxic Doses for Sheep.

HCN Content of Fresh Plant.	Fatal Dose in—
0.02 per cent.	500 gms.
0.03 ,, ...	333 ,,
0.04 ,, ...	250 ,,
0.05 ,, ...	200 ,,
0.06 ,, ...	166 ,,
0.07 ,, ...	142 ,,
0.08 ,, ...	125 ,,
0.1 ,, ...	100 ,,

HCN Content of Air-dried Plant.	Fatal Dose in Dried Plant.
0·05 per cent.	200 gms. (equal to 500 gms. of fresh plant)
0·1 ,, ...	100 ,, ,, 250 ,, ,,
0·15 ,, ...	66 ,, ,, 165 ,, ,,
0·2 ,, ...	50 ,, ,, 125 ,, ,,
0·25 ,, ...	40 ,, ,, 100 ,, ,,
0·3 ,, ...	33 ,, ,, 80 ,, ,,
0·4 ,, ...	25 ,, ,, 62 ,, ,,
0·5 ,, ...	20 ,, ,, 50 ,, ,,
0·75 ,, ...	13 ,, ,, 32 ,, ,,
1·0 ,, ...	10 ,, ,, 25 ,, ,,

7. Do the Naturally Fatal Doses Approximate these Figures ?

It has been shown from the above that if sufficient enzyme is present in the animal, the glucoside is readily split with liberation of HCN, and that under such conditions the glucosides sambunigrin and prunasin are fatal for sheep when the HCN content of the glucoside is equal to 1 mgm. per lb. body weight of the animal.

From the practical point of view, it is necessary, however, to know whether sufficient enzyme to accomplish this liberation of HCN is present in the stomachs of normally pastured sheep. It is well known that the enzyme content of plants varies, and that, therefore, one may reasonably expect that the amount of enzyme present in the stomachs will likewise vary with the fodder.

To obtain some light on this aspect of the problem, two experiments were undertaken.

Experiment 10—

Sheep No. 280.—Weight 55.5 lb.

Plants.—*Eremophila maculata* (as used in previous experiments). 6.7 gms. of air-dried plant, mixed with 8 oz. water, administered as a drench.

Enzyme.—No enzyme intentionally administered to this animal. The sheep was taken from natural pasture (chiefly native grasses) and drenched with the cyanogenetic plant about one hour after being taken from the pasture.

Result.—The sheep showed definite symptoms in 10 minutes after administration, and these persisted for about an hour, later passing off and the animal recovering.

Experiment 11—

Sheep No. 515.—Weight 70.25 lb.

Plant.—*Acacia glaucescens* (as used in other previous experiments). 38.2 gms. of plant suspended in one and a half pints of water and drenched.

Enzyme.—No enzyme specially administered to this animal. It had been running on natural pasture, along with sheep No. 280, for some weeks, and was brought in from the paddock at the same time as that animal. Thereafter, it was penned and fed freshly-gathered green trefoil (*Medicago denticulata*) daily for five days, receiving about 1 lb. per day. The day previous to drenching it was starved, and the next morning was given 1 lb. trefoil, which it consumed within an hour. An hour later it was given another 1 lb. of trefoil, of which $\frac{3}{4}$ lb. was eaten readily. The sheep was then drenched, this being four hours after the first feed of trefoil, and two hours after the second feed.

Result.—Sheep showed symptoms in 15 minutes, these soon becoming very marked, and the animal died $1\frac{1}{2}$ hours after administration of the drench.

Commentary on the Above.

Experiment 11 shows quite definitely that sheep on certain natural pasture may gather sufficient enzyme to split a minimal fatal dose of a cyanogenetic plant, which in itself contains practically no enzyme. From Experiment 10, however, in which a sheep on other grasses suffered intoxication but did not die, it would appear that the amount of enzyme present in the native pasture grasses may be considerably less than that present in trefoil. Certainly, at times, the diet of sheep may be restricted to few plants, but, generally speaking, it is quite varied, and it seems reasonable to assume, therefore, that at least, at times, sheep will feed on plants which may contain adequate enzyme to split all the cyanogenetic glucoside in cyanogenetic plants which they may eat.

8. Conclusions.

1. The fatal dose of a cyanogenetic plant depends, not only on the cyanogenetic content, but also upon the amount of enzyme available.

2. If the plant itself is deficient in enzyme, such may be provided from other herbage recently ingested.

3. Where adequate enzyme is present, the whole of the glucoside may be rapidly hydrolyzed so that the fatal dose of a cyanogenetic plant is that quantity of the plant which contains cyanogenetic glucoside, the HCN equivalent of which is equal to the minimal fatal dose of HCN for an animal of that weight.

4. Assuming that a sheep may eat on an average 500 grammes of fresh plant, the percentage of HCN which would render such plant able to cause fatal effects would be 0.02 per cent.

5. Analyses are usually made on the air-dried plant, and a figure of 0.05 per cent. HCN, if obtained in the air-dried plant, is to be regarded as the minimal percentage which would ordinarily be followed by fatal effects if the plants were eaten in the fresh state. It is, of course, the percentage figure at which the plant in the dried state would be considered dangerous.

6. Dried cyanogenetic plants are commonly deficient in enzyme, but, as enzyme may be forthcoming from some other foodstuff eaten, dried cyanogenetic plants may be followed by fatal effects.

7. Whilst these represent the lethal doses, the minimal toxic dose is, of course, smaller; but from our experiments, it would appear that the minimal toxic dose is about half the above figures. With these symptoms may be induced, but animals recover.

8. Whilst the above may be held to occur with plants in which the glucoside is either sambunigrin or prunasin, it does not, of course, necessarily mean that the same would be the case with plants in which there is a different glucoside. On the other hand, we do not see why the results should differ.

9. References.

1. Finnemore & Cox, *Proc. Roy. Soc., New South Wales,* **62** (1929), p. 369.

2. Petrie, *Proc. Linn. Soc., New South Wales,* **45** (1920), pp. 447-459.

Tobacco Investigations.

By C. M. Slagg, M.Sc., Director of Investigations.

1. The Organization of the Australian Tobacco Investigations.

The Australian Tobacco Investigation was initiated in July, 1927, as a result of a proposal by the British-Australasian Tobacco Company, and later of an agreement between the Federal and mainland State Governments and the Tobacco Company. The Development and Migration Commission and the Council for Scientific and Industrial Research were responsible for carrying out the negotiations. A trust fund was set up to defray the costs of the Investigation, this fund being contributed to by the Tobacco Company, the Federal Government, and the five mainland States. Briefly, the agreement was that, during a period of three years, the Tobacco Company would contribute £20,000, the Commonwealth Government £5,000, and each mainland State Government £1,000, making a total of £30,000. If at the end of this first period of three years the results are sufficiently encouraging to warrant further effort, and the parties to the agreement concur, a further sum of £60,000 will be provided. Of this the Tobacco Company will contribute £30,000, the Commonwealth Government £15,000, and each mainland State Government £3,000. It will be observed, therefore, that if the work be continued over the full period, a total of £90,000 will be devoted to the improvement of the tobacco industry.

An Executive Committee was appointed to control the finance and general policy of the Investigation, and an Advisory Committee, composed of the administrative heads of the mainland State Departments of Agriculture, is consulted from time to time. Later, a Research Committee was also set up, the aim being to relieve the Executive of the necessity of deciding on technical details, and to facilitate more effective supervision of co-operative research. A plan of the general organization is shown in Table I.

During the two years of the Investigation which have elapsed, a staff of workers has been secured, and an organized scheme of procedure planned and put into operation. The chart of organization of activities is presented in Table II. It should be stated that it has not yet been possible to start work on all the phases of activity listed in this table. Nevertheless a series of 24 separate projects are already under way or to start during the present fiscal year. Co-operative relations have been established with the Departments of Agriculture of each of the five mainland States, and with the Division of Economic Botany of the Council for Scientific and Industrial Research. The personnel of the Executive Committee, the Research Committee, and the Investigation staff are given below:—

Executive Committee—

- H. W. Gepp, Chairman of the Development and Migration Commission (Chairman).
- A. C. D. Rivett, M.A., D.Sc., Chief Executive Officer, Council for Scientific and Industrial Research.
- G. P. Darnell-Smith, D.Sc., F.I.C., Director of the Botanic Gardens, Sydney.
- S. S. Cameron, D.V.Sc., M.R.C.V.S., Chairman of the Standing Committee on Agriculture of the Council for Scientific and Industrial Research.

Research Committee—

C. M. Slagg, M.Sc., Director of Tobacco Investigations (Chairman).

B. T. Dickson, B.A., Ph.D., Chief of the Division of Economic Botany, Council for Scientific and Industrial Research.

Members of Staff—

C. M. Slagg, M.Sc., Director.
V. F. Olivier, B.Sc., Agronomist.
G. E. Marks, Assistant Agronomist.
A. V. Hill, B.Sc.Agr., Assistant Pathologist.
R. W. Howell, Field Supervisor (Queensland).
H. J. Limmer, Field Supervisor (Western Australia).
S. Fowler, Secretary to the Executive Committee.
T. L. McCrohan, Senior Clerk.

At present the head-quarters are located on the 6th floor of the Commonwealth Railways Building, 150 Flinders-lane, Melbourne. Some members of the staff are located away from head-quarters, including Mr. R. W. Howell, at Mareeba, Queensland; Mr. H. J. Limmer, at Manjimup, Western Australia; and Mr. A. V. Hill, temporarily at Tumut, New South Wales. Office and laboratory space has been offered to the Investigation by the Council for Scientific and Industrial Research in the new buildings of the Division of Economic Botany at present under construction at Canberra. An area of land has been set aside there for experimental purposes, and it is also proposed that the Australian Tobacco Investigation erect one of the green-house units. These proposals are at present under consideration.

2. Co-operative Relations.

In each of the five mainland States, the experimental work is carried out in co-operation with the State Departments of Agriculture. The cost of this work, as well as the travelling expenses of State officers assisting in the work, is borne by the Tobacco Investigation. Co-operative research in tobacco diseases has already been arranged with the Division of Economic Botany of the C.S.I.R., and Dr. H. R. Angell, a Senior Pathologist of that Division, is engaged upon a study of the blue mould disease of tobacco. One Assistant Pathologist, Mr. A. V. Hill, has been assigned to work with Dr. Angell, and other assistance is provided as needed. The full cost of this disease work is borne by the Tobacco Investigation. A portion of Dr. Dickson's salary and travelling expenses is also paid from Tobacco Investigation funds, in return for his services as a member of the Research Committee.

Contacts have been established with most of the Universities, and it has been possible to arrange for work in their research laboratories. This has been mainly in the Universities of Sydney, Melbourne, and Adelaide. It is hoped that this type of effort may be extended.

3. Aims of the Investigation.

The aim of the Australian Tobacco Investigation is the improvement of the tobacco industry. It is evident from the outset that three groups of people must be considered, namely, the producers, the manufacturers, and the consumers. The interests of any one of these groups cannot, with safety, nor for long, be neglected. Nevertheless it is clear

that we must have adequate production before either manufacturer or consumer can be satisfied. Therefore the present activities of the Investigation deal almost entirely with production. It is hoped to improve the quality and increase the quantity of home-grown tobacco taken for manufacture, until at least the major part of the cured leaf used in Australian tobacco factories will be grown in Australia. When this point has been reached, the possibilities of an export market can be considered. Australia enjoys, together with the other self-governing Dominions and the Crown colonies, a preference of two shillings per pound less duty on all raw-leaf tobacco exported to the United Kingdom. Here is a large market at hand, provided the quality of locally-grown tobacco can be improved, and its production placed on a sound economic basis, so that it can compete on the English market with tobacco from other parts of the Empire.

But out first aim must be to satisfy the Australian manufacturer. At present less than 10 per cent. of the raw leaf taken for manufacture is home grown, despite the fact that tobacco has been grown commercially in Australia for at least 60 years, and that we have an import duty of 3s. per lb. on raw leaf. The improvement of tobacco in the existing commercial areas, and the testing of new areas, must therefore receive major attention.

4. General Scope of Work.

Exploratory and general agronomical field tests are under way in each of the five mainland States of the Commonwealth.

The exploratory tests consist of small plots of tobacco grown outside the commercial areas at widely separate points where soil and climate appear favorable, the idea being to ascertain the smoking qualities of the leaf from these plots.

The field experiments are most extensive in New South Wales and Victoria, because of the presence in these States of the principal commercial-producing areas. This field work is concentrated at as few places as is possible. At present, field work in Victoria is mainly carried out at the State Experimental Farm, Wahgunyah, at Myrtleford, and at Pomonal. In New South Wales, this work is located at the Bathurst State Farm, at Tumut, and at Tamworth. In Queensland, the agronomical work is concentrated at Mareeba, in South Australia at Mount Barker, and in Western Australia at Manjimup.

The pathological work is at present being carried out at Melbourne, Sydney, and Canberra, with seed-bed disease tests under way at Myrtleford (Victoria) and Tumut (New South Wales).

The warehouse and factory tests to date have been made in Melbourne, Sydney, and Perth, and the Investigation gratefully acknowledges the co-operation and assistance, in these packing and manufacturing tests, of the British-Australasian Tobacco Company, Melbourne and Sydney; of Messrs. Dudgeon and Arnell, Melbourne; of G. G. Goode and Company, Melbourne; and of P. Michelides, Perth.

5. Publications.

To date two scientific articles, one general article, and two bulletins have been published on work carried out under the Australian Tobacco Investigation. The titles of these publications are as follows:—

Bulletin No. 1.—"Report on a trip through the South-eastern Atlantic States of the United States of America, with particular reference to the production of bright flue-cured tobacco"—by Dr. G. P. Darnell-Smith.

Bulletin No. 2.—"The smoking qualities of Australian tobacco"—by C. M. Slagg.

Article No. 1.—"The production of bright flue-cured tobacco in America"—by Dr. G. P. Darnell-Smith, in the *Journal of the Council for Scientific and Industrial Research* for February, 1928.

Article No. 2.—"A reconnaissance of some Australian tobacco soils, with reference to reaction and mechanical analysis"—by E. P. Bainbridge in the *Journal of the Council for Scientific and Industrial Research* for November, 1928.

Article No. 3.—"Blue mould of tobacco—Investigations concerning seed transmission"—By Dr. H. R. Angell in the *Journal of the Council for Scientific and Industrial Research* for August, 1929.

TABLE I.

General Organization and Co-ordination of the Australian Tobacco Investigation.

1. Administration—

    Executive Committee.
    Director of Investigations.
    Research Committee.

2. Consultation—

    The Executive Committee, the Director and the Research Committee in consultation with the Advisory Committee (Permanent heads of State Agricultural Departments), Tobacco Growers' Association, and tobacco manufacturers.

3. Exploration—

    Director and members of staff in co-operation with State Departments of Agriculture.

4. Experimentation—

    Director and members of staff, co-operating with Division of Economic Botany, C.S.I.R., and with State Departments of Agriculture.

5. Research—

    Research Committee and members of staff of Australian Tobacco Investigation co-operating with Divisions of C.S.I.R., with Universities, and with State Departments of Agriculture.

6. Publications—

    Bulletins of the Australian Tobacco Investigation.
    Scientific articles in appropriate journals.
    Joint bulletins with State Departments of Agriculture.
    Press articles.

TABLE II.

Chart of Organization of Activities of the Australian Tobacco Investigation.

Field Tests.

(*a*) Exploratory Plot Tests

(*b*) Agronomical—
1. Variety tests.
2. Fertilizer tests.
3. Rotations.
4. Methods of culture and harvest.
5. Methods of curing.
6. Seedbeds.
7. Seed production.

(*c*) Pathological—
1. Seedbeds.
2. Field.

(*d*) Entomological—
1. Seedbeds.
2. Field.

Laboratory Tests.

(*a*) Exploratory Test Plots—
1. Burn.
2. Ash.
3. Aroma.
4. Physical and chemical constitution.

(*b*) Agronomical—
1. Smoking qualities of various plot tests.
2. Physical and chemical constitution of various plot tests.

(*c*) Pathological—
1. Blue mould.
2. Stalk rot.
3. Virus diseases.
4. Other diseases.

(*d*) Entomological—
1. Cutworms.
2. Stem borers.
3. Budworms.
4. Nematodes.
5. Cigarette beetles.

(*e*) Physiological and chemical studies on aroma in tobacco.

Warehouse and Factory Tests.

(*a*) Packing and aging of exploratory test plot leaf.

(*b*) Packing and aging of various field test plots.

(*c*) Experimental Manufacture—
1. Leaf from agronomical and exploratory tests.
2. Blends of Australian leaf from various sources.
3. Blends of Australian with foreign leaf.

(*d*) Methods of improvement of Australian leaf by processing—
1. Heat.
2. Moisture.
3. Added substances.
4. Removal of injurious substances.

(*e*) Pathological—storage maladies of leaf tobacco—
1. Mould.
2. Black rot.

(*f*) Entomological—
1. Cigarette beetle.

Miscellaneous.

(*a*) Statistics—
1. Australian Production — raw leaf / manufactured leaf.
2. Import and export by types.

(*b*) Economics of production and manufacture.

Notes on the Pasture Problem in Australia.

By Dr. Alexander Nelson.

Shortly after his departure from Australia, Dr. Nelson furnished the Council with some notes on his ideas of the pasture problem of the Continent. The following article has been prepared from the notes in the belief that it contains some interesting suggestions in regard to some aspects of the problem. As Dr. Nelson himself points out, his notes do not pretend to be a complete discussion. It should also be realized that Dr. Nelson was located in Tasmania during his stay in Australia, and naturally was most conversant with the pastures of that State.—[Ed.]

The following notes are from observational evidence, collected as opportunity presented itself, from the doings of the practical man in the field. They are offered at this stage as the writer will not now be in a position to develop the experimental work which might have been based upon these preliminary data.

In this discussion of Australian pastures and conditions, one must be understood as referring to the large areas at present carrying sheep and which, if to pay dividends, either must be reduced in capital value or increased in carrying capacity. The writer does not pretend to have inquired into the position with the thoroughness necessary for a complete discussion, but offers these notes for what they are worth.

The problem in Australia essentially seems to be to increase carrying capacity either by the production of pasture from introduced species or improvement of the native pasture. This has to be done under conditions contrary to those declared by formal teaching to be pre-requisite for success and, most important of all, it must be done at an economic cost.

The tendency in Australia up till recently has been to colour, as far as possible, most ideas in connexion with pasture with ideas imported from Britain and New Zealand. Certainly, both in Australia and in Britain, there is in the annual history of the pasture a period of low vital activity with its low productivity and coupled, to some extent, with a killing off of certain of the pasture constituents. The attempts to establish a relationship between British-New Zealand conditions and Australia have been unfortunate, because, on analysis, it is clear that the positions are not comparable.

British conditions imply in practically all cases a fairly retentive soil with a rainfall approximating to 30 inches, in fact, the typical pastures are limited to areas receiving about this figure or better. It is probable that in Australia a higher minimum figure or equivalent moisture supply is necessary for "perfect" pasture owing to the higher insolation.

In Britain and New Zealand (South Island particularly) the environmental imposed period of low vital activity (and therefore low productivity) follows on low temperature and is rarely lethal. The low-temperature period occurs at the period of maximum moisture supply, but may in extreme cases be accompanied by an ice-induced drought effect. This ice effect and simple uprooting following the thaw may prove fatal, but it may be said that the greater economic effect of the stress period under British conditions lies in reduced productivity. These conditions inducing low vital activity do not come on suddenly, but the pasture is well prepared for the period of stress. The fall in temperature is gradual. To sum up, it may be said that the period of

stress for the pasture is rarely fatal to the constituents, is gradual in its onset, and occurs at a time of low temperature accompanied by maximum moisture supply.

On the other hand, the Australian pasture has to face a quite different period of stress. Through a period of lower temperatures accompanied by higher rainfall, the pasture reaches maximum vital activity. Then passes, more or less rapidly, a period of rising temperatures inducing, if anything, increased growth activity, until with comparative suddenness the period of stress is upon the plant. This stress takes the form of conditions of high temperature, high insolation, and minimum moisture supply. In short, the Australian pasture has to face annually, a period of stress due to drought conditions, and this period, even in a normal year, is likely to be fatal at least to the higher-producing species.

The answer to the British problem with its conditions of moisture and low temperature cannot therefore be the answer to the Australian conditions. It has long been economic for the British farmer to provide feed for his stock, in order to carry them easily through this period of low productivity, and it is believed that this too will be economic in Australia. The methods by which this can be done are varied, and one method which it is believed will fit into the extensive system of Australia will be detailed below.

It may be said that for the general Australian "extensive" system of stock production, "temporary" pastures, as they are known, are not economic. Over the very large areas involved, frequent sowings are not practical. The pasture once initiated must continue without any great attention for a reasonably extended period. "Permanent" pasture only will be economic. Another point may be made—over a very long range of Australian property "permanent" pasture will have to be produced involving very low costs. Botanically, this means finding a cheap method of carrying the pasture over the annual lethal period of stress.

Having narrowed the problem down, it now falls to offer a solution. One line of approach is to turn to the plant breeder and plant selector. This was done in Britain where a simple answer was obtained. There, natural conditions have produced winter hardy strains and long-lived types which, when multiplied, will ensure more permanent pastures.

This line of approach, however, is not too attractive to the Australian worker. It is not likely that the introduced species will have, as yet, provided adaptations "ready made" as occurred in Britain, and to wait for mutations is not practical. It is possible that much may be done by the plant breeder with the native species, especially in selecting for greater productivity.

For an immediate, though possibly partial, answer to the problem, it would seem more profitable to examine the plants as we have them and, if possible, adapt a system of management to them which will enable an association to weather the period of stress. It will be useful to go back to first principles and note how, in general, the species arranges to carry on when the conditions are inimical to the individual It is a matter of elementary botany that the higher plants rely on two main methods for

the perpetuation of the species. One is the production of sexually-produced seeds, and the other the production of rhizomes, corms, bulbs, &c., originating vegetatively.* Both of these methods for species survival may be of use to the Australian pastoralist.

As far as the vegetative method is concerned its use may be taken as limited to those cases where the species has adopted under-ground structures such as rhizomes, corms, &c. Species of this nature in most countries of intensive culture are disliked, because, under these conditions, the under-ground creeper is a bad "weed," hard to eradicate—too permanent, in fact. Under Australian conditions, this would not be a serious difficulty, but the fact that the under-ground creeper stores a considerable amount of the food material manufactured, underground, and inaccessible to stock, is serious. Various "couch grasses" and "onion twitches" have been noted in practice and appear useful. The possibilities of *Trifolium medium* amongst the *Leguminosae* are interesting. There is no doubt that a sward could be constructed composed entirely of species with vegetative structures situated below the ground, and because of this, capable of resisting extremely adverse conditions. An association of this type would require to be seeded in the first instance (on account of cost), and out of this arises a greater objection to the vegetative method than the botanical ones mentioned above. When one turns to the economic aspect of the vegetative method, it has to be noted that, as a general rule, species which derive their perenniality from vegetative adaptations produce a paucity of seed with resultant high prices. This means fairly heavy sowings of expensive seed. Further, though under cultivation conditions such species spread quickly, such is not the case under pasture conditions and, therefore, the whole area under consideration would require to be seeded. These economic limitations to the use of vegetative propagation in addition to the botanical limitations will never permit of its wide general application.

Undoubtedly the most successful method of tiding over a period of stress employed by the higher plants is through the seed. The seed acts as a method of increase for the species, a method of dispersal, &c., but from the point of view of this discussion it is most important as a method of resisting bad conditions. If a system of management can be evolved to exploit this attribute to the full, then it may be that it will provide the most economic line of approach to the problem. Such a system of management will demand species which will produce a mass of feed quickly from the germinating seed, which will mature quickly, and later, at the onset of the annual drought-stress period, ripen a mass of seed capable of germinating when the autumn rains come, and in this way reproduce the association. This description is filled by a very large number of species, particularly the smaller clovers and medics. That it is possible to establish annuals which will grow up, produce feed, and then self-sow sufficient seed to ensure the same thing happening the following and subsequent years without further sowing has been amply demonstrated by the practical man in his use of subterranean clover. The idea behind the use of subterranean clover is capable of wider and fuller application. This use of subterranean clover is but the first step to the "self-regenerating," "permanent" pasture composed of annuals.

From the cost point of view the "self-regenerating" pasture which, though composed of annuals, is "permanent" because of its re-seeding

* It may be permitted in this writing to regard the vegetatively originating individual as a product of the plant which produced the vegetative structure, though strictly there is no discontinuity between the two expressions of the one individual.

capabilities, is, perhaps, the cheapest that can be devised. In the first place, the cost of the seed of these annual types is, because of their prolific production, low, and the quality high. Further, if a very large area is under consideration the capital costs involved can be kept low. The whole area need not be, and, in fact, should not be, sown, but comparatively small "islands" of the mixture established throughout the area. These develop, and rapid seed dispersal soon colonizes the whole area. This method of colonization would permit of the rise in carrying capacity synchronizing with the necessary rise in stock numbers without undue financial upset in the organization.

Over large areas in Australia, considerable increases in carrying capacity have been obtained from the use of phosphatic manures. The successes obtained from top-dressing have been due in large part to the response made by the small annual clovers which have been present in the paddock, but incapable of full development, owing to the lack of phosphate. Most of the failures in top-dressing, where moisture supply has been reasonable, can be ascribed to the non-appearance of the clovers, or they have not been present initially. It is suggested that top-dressing should, in many cases, go hand in hand with colonization by a self-regenerating pasture complex.

Under a system of self-regenerating pasture, a gap in feed production will necessarily occur. As the profit of pasture management lies in the exploitation of the "flush" period, some step must be taken to deal with the period of scarcity. Either the stocking of the area must fluctuate either naturally or artificially with the natural fluctuations of the pasture, or some form of "artificial" feeding must be resorted to. In practice a combination is usual. In some cases special crops are grown and harvested, or hay saved, or silage made, &c. The profit of grass land lies in keeping the stocking up to the point where sufficient are carried over to exploit later the period of maximum feed production.

In this connexion, practice in Australia has evolved a cheap method and along the same lines as the pasture. This is by what may be called a "self-perpetuating" grain crop. The annual lupin of a non-poisonous type offers a bridge over the gap in pasture production, and possible other species may be discovered which will serve similarly.* As grown in West Australia, particularly, this plant is sown and allowed to develop at the same time as the pasture is growing, but it is rarely if ever fed. The lupin is allowed to grow on and mature its seeds. After the seeds have been shed, which is the time when the pasture is going off, the sheep are turned in. A good field of lupin seed will fatten not less than five sheep per acre. In managing an area of lupin under this system, the aim is to feed to such a point and no further, that there is still sufficient seed left in the ground to ensure a crop the following year. Thus there is a "self-regenerating" grain crop available to fill the gap when the "self-regenerating" pasture has gone off.

Appendix 1.

The observations on which these notes are based were made principally in Tasmania and with some reference to the Tasmanian grass grub (*Oncopera intricata*). The life history of this insect, and an account of the damage it does, has been given in a publication† of the

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* Many of the beans for example.
† Council for Scientific and Industrial Research, Australia. Pamphlet No. 11 (1928).

Council. It is thought that some modification of the pasture management methods outlined above will provide an almost complete answer to the pest.

The grub rarely covers the whole of any wide area: its attacks are usually somewhat patchy. The attack on clover is usually slight. It seemed quite definite to the writer that if the pasture were capable of regenerating or recovering after an attack, the present almost total loss would be obviated. Certainly the position would be considerably improved if after an attack something better than "flat weed" came up as is usual at present. In the moister areas of Tasmania, ás, for example, Scottsdale, the method of vegetative propagating would provide a possible answer. In Tasmania, the areas are small, and colonization by "twitches," "couches," &c., would be possible and not undesirable. In this connexion, it has been commonly noticed that "browntop" and other *Agrostidae* resist the grub and are the chief survivors of an attack.

Appendix 2.

One aspect of the self-regenerating pasture bears on the question of seed analysis. In European practice, the "hard seed" of clovers and delayed germination types in grasses are looked upon with disfavour. Seedsmen go to considerable trouble to eliminate them from a consignment. In Australian practice, the "hard seed" particularly must be regarded as valuable in that it will provide an insurance for establishment. In many cases at the end of the dry spell a few showers fall, sufficient to induce germination. A short but hot and dry period follows, sufficient to drought off the seedlings. The "hard seed" ensures a second chance. It is believed by a number of authorities that the ability to produce "hard seeds" is inherited, and, until this be disproved, it will be advisable to ensure a certain proportion of hard seeds in all initial sowings.

Freezing and Chilling of Prime Young Beef.

By W. A. Empey, B.V.Sc., Investigator to the Committee.

(Report of investigations carried out on behalf of the Meat Preservation Committee of the Australian National Research Council and of the Council for Scientific and Industrial Research.)

The Meat Preservation Committee consists of Dr. J. A. Gilruth (Chairman); R. P. Allen, Esq., and Ross Grant, Esq. (Department of Markets and Transport); the Honorable W. Angliss, M.L.C.; Professor W. A. Osborne and Dr. W. J. Young (University of Melbourne); Professors H. G. Chapman and J. D. Stewart (University of Sydney); R. Crowe, Esq., and J. Hepburn, Esq. (Victorian Department of Agriculture); G. Lightfoot, Esq. (C.S.I.R.); C. Wilson, Esq. (Scott's Hotel), and T. Vincent, Esq. (Metropolitan Farm). The Council desires to take this opportunity of gratefully acknowledging the help afforded by the above, and by the organizations they represent; and also the helpful co-operation afforded, in connexion with the tests described below, by the officers of the Metropolitan Farm, and particularly Mr. T. Vincent, and by Messrs. Angliss and Company.—[Ed.]

1. Introduction.

In the course of the work carried out on the cold storage of beef by the Meat Preservation Committee, it was found, as the result of a series of experiments, that when prime young beef was used, it was difficult to distinguish in the cooked state between frozen and chilled portions of the same carcass. The animals used in these experiments were from three years to four years of age, but in view of the growing demand on the English markets for "baby beef," it was considered advisable to conduct an experiment with even younger animals.

Arrangements were accordingly made with the Metropolitan Board of Works, Melbourne, for securing six specially fattened prime two-year-old steers, the history and treatment of which are given in detail in subsequent chapters.

2. History of Selected Steers.

The six selected steers, comprising two of each of the Aberdeen Angus, Shorthorn, and Hereford breeds, were chosen by the Committee of the Metropolitan Farm, Werribee, for competition in the export steer and fat steer sections at the Royal Agricultural Society's Show, held at Melbourne in September, 1929.

The animals were calved in August, 1927, and were all sired by pedigree bulls from good non-pedigreed cows of the respective breeds. They were kept on their mothers, on irrigated pasture, until weaned at about eight to nine months old, and were then run on irrigated pasture alone until 24th June, 1929. From this date, until 21st August, they were fed in the paddock the following ration twice daily, in addition to the grazing:—

> 6 lb. oaten chaff, 1 lb. crushed oats, 1 lb. ground maize, 1 lb. bran, 1 lb. pollard, 6 lb. molasses, 1½ lb. sheep nuts or Meggett's meal.

Until 13th August they also received between them 2 cwt. of oaten hay three times a week.

On 21st August the animals were weighed, when it was found that one Aberdeen Angus steer and one Shorthorn steer were each 35 lb. over the maximum live weight stipulated by the Royal Agricultural Society, viz., 1,400 lb. These two steers were then turned onto grass only, in an un-irrigated paddock, and the remaining four had their ration fed to them thrice instead of twice daily, the object being to have the pairs as evenly matched as possible within the prescribed weight.

On 3rd September, the animals were re-weighed, when it was found that, in the fortnight on grass, the Aberdeen Angus steer had lost 112 lb. and the Shorthorn 63 lb. These beasts were then put back on the same rations as the others until trucked to the Show, on 16th September, where they were fed as usual.

From 24th June, 1929, to 21st August, the rations fed, in addition to grass, cost 5s. 6d. per head per week for the six steers; then to the 3rd September 7s. 9d. per head per week for the four steers kept on hard feed, and the same for the six from then on. The total cost per head for supplementary feeding during the period from 24th June to the 18th September was £3 17s. 4d. for each of the four steers, which had an uninterrupted preparation, and £3 3s. for each of the two steers which had become overweight.

3. Slaughtering.

At the conclusion of the Show, the animals were driven by road to the works of Messrs. Angliss and Company, Footscray,* and after a resting period of 24 hours, were slaughtered on 30th September. A record was kept of the live weight, hot-dressed weight, and cold-dressed weight (after hanging in sides for 24 hours at 38 degrees F.). These weights were as follow:—

Animal.	No.	Live Weight.	Hot Dressed Weight.	Cold Dressed Weight.	Loss in Dressing and Cooling.
		lb.	lb.	lb.	Per cent.
Aberdeen Angus ..	1	1,324	872	852	35·6
Aberdeen Angus ..	2	1,292	800	770	40·4
Hereford	1	1,148	689	665	42·0
Hereford	2	1,330	834	800	39·9
Shorthorn	1	1,376	816	783	43·1
Shorthorn	2	1,362	856	819	39·9

The carcasses were inspected by members of the Committee, who chose portions for experimental purposes as follows:—

(a) *Tests in Australia.*—Rumps and loins from Aberdeen Angus (2), Hereford (2), Shorthorn (1).

(b) *Export to England.*—Whole sides (divided into fore-quarters and hind-quarters) from Aberdeen Angus (1), Hereford (1), Shorthorn (2).

4. Cold Storage.

For the tests in Australia, three rumps and loins, one from each of the three breeds, were frozen in circulating air at 5 degrees F., and the corresponding portions from the opposite sides of the same carcasses

* About two miles away.

were chilled at 38 degrees F. in a direct expansion room. Prior to export to England, the three sides were frozen at 5 degrees F. for seven days. In each case the beef was hung for 48 hours at 38 degrees F. before commencement of freezing.

After ten days' freezing, the beef retained for the Australian tests was thawed in air at 55 degrees-65 degrees F. for two days, and then held at 38 degrees F., together with the chilled beef, until required for consumption.

During cold storage, the following losses in weight were recorded:—

Beef.	Weight before Storage.	Period of Storage.	Weight after Storage.	Loss in Weight.	Loss in Weight.
	lb.		lb.	lb.	Per cent.
Frozen	1,168	7 days	1,161	7	·60
Frozen	287	10 days	285	2	·7
Chilled	290	15 days	289	1	·35

5. Cooking Tests.

Cooking tests were divided into two sections:—

(*a*) Hotel. (*b*) Private.

(*a*) *Hotel Tests.*—Through the courtesy of Mr. C. Wilson, Proprietor of Scott's Hotel, arrangements were made for conducting a cooking test at the hotel. The four portions chosen from Hereford (2) and Aberdeen Angus (2) were sirloins of similar cuts from the opposite sides of the same carcass, one side having been frozen and the other chilled in each case.

Prior to being placed in the oven, the frozen beef had been subjected to the following treatment:—

> Two days' chilling at 38 degrees F., ten days' freezing at 5 degrees F., two days' thawing at 55 degrees-65 degrees F., and a concluding day's chilling at 38 degrees F.

During the same period, the chilled beef had undergone fifteen days' chilling at 38 degrees F.

The four portions were roasted side by side, in the same oven, for about three and a half hours. Seventeen people, including members of the Meat Preservation Committee and of the Metropolitan Board of Works were present at these hotel cooking and eating tests, and each received simultaneously on the one plate two portions of roast, one from the frozen and the other from the chilled beef of the same breed. None of the participants was aware of the identity of the samples, which were merely numbered 1 and 2. After tasting, each person gave written opinions on special forms provided, of such points as appearance when cooked, juiciness, flavour, tenderness, quality of fat, &c., and in addition, each one expressed a preference for one sample or the other.

When carved, it was noticed that one of the Aberdeen Angus joints had not been cooked to exactly the same degree as the other of the same breed, so a comparison was confined to the two uniformly cooked Hereford roasts. For the purposes of comparison it was found convenient to tabulate the three main points—juiciness, flavour, and tenderness—on the following scale:—Very good, 100; good, 80; fair, 60; poor, 40.

The results by means of this comparative method were:—

Beef.	Treatment.	Juiciness.	Flavour.	Tenderness.
Hereford	Chilled ..	63	77	86
(Roast Sirloin)	Frozen ..	68	78	84

Taking all points into consideration, the views expressed were as follows:—

Preference for Chilled.	Preference for Frozen.	Equal.
5	6	6

The relatively low points recorded for juiciness would probably be due to the degree of cooking.

(*b*) *Private Tests.*—For the purpose of private tests, members of the Committee and others were supplied at their homes with samples of steak and roasts from both chilled and frozen beef, the cuts of which were taken in each case from opposite sides of the same carcass. The two portions of steak and the chilled roast were sent on the one day, but the frozen roast was held for an additional three days at 38 degrees F. before delivery. Members were supplied with forms for criticism, and in the majority of cases the opinions given were those of several people.

The treatment to which the various samples had been subjected before cooking was as follows:—

Frozen Steaks.—Two days' chilling at 38 degrees F., ten days' freezing at 5 degrees F., two days' thawing at 55 degrees-65 degrees F., and a final day's chilling at 38 degrees F.

Chilled Steaks.—Fifteen days' chilling at 38 degrees F.

Frozen Roasts.—Two days' chilling at 38 degrees F., ten days' freezing at 5 degrees F., two days' thawing at 55 degrees-65 degrees F., and a final 5 days' chilling at 38 degrees F.

Chilled Roasts.—Fifteen days' chilling at 38 degrees F.

The same system for allocation of points as previously was adopted, with the addition of points for appearance before cooking, and the results were:—

Beef.	Treatment.	Appearance Before Cooking.	Juiciness.	Flavour.	Tenderness.
Steaks	Chilled ..	71	76	76	86
Steaks	Frozen ..	73	83	75	77
Roasts	Chilled ..	71	78	73	85
Roasts	Frozen ..	73	73	67	88

It will be noticed that the points given for juiciness are higher than those recorded in the hotel test, probably on account of the difference in degree of cooking.

Taking all points into consideration, the views expressed were as follows:—

Beef.	Preference for Chilled.	Preference for Frozen.	Equal.
Steaks	5	6	8
Roasts	7	4	3

(*c*) *Summary of Hotel and Private Tests.*

1. In the inspection before cooking, opinions on the appearance showed a slight preference for the frozen material due to the fresher appearance of the fat which had lost a little of its bloom in the chilled. The appearance of "drip" or weeping in the frozen steak was commented upon by four persons.

2. In the cooked state, the fat of the frozen beef was generally considered better in appearance and flavour than the chilled.

3. Four opinions were given that the beef was too young for a satisfactory test of flavour, and three people considered that neither the chilled nor the frozen beef compared favorably in any respect except tenderness with prime fresh beef.

4. Taking into account appearance before cooking, juiciness, flavour, and tenderness, the average percentages were:—

——	Appearance Before Cooking.	Juiciness.	Flavour.	Tenderness.
Chilled Beef	71	76	76	86
Frozen Beef	73	73	73	83

5. A summary of the preferences given in both tests was:—

Preference for Chilled.	Preference for Frozen.	Equal.
17	16	17

(*d*) *Conclusion.*—The conclusion arrived at is that chilled and frozen portions of the prime young beef used in this experiment were indistinguishable.

6. Beef Exported.

Three sides of beef, divided into forequarters and hindquarters, after two days' chilling at 38 deg. F. and seven days' subsequent freezing at 5 deg. F. were exported in the frozen state to London on 10th October per the R.M.S. *Chitral,* and were received at Smithfield market on 26th November.

In order to improve their appearance for marketing, the forequarters which were declared to be free from beef nodules, were sent

with the briskets intact, by special permission. On arrival at Smithfield, the beef was exhibited by Messrs. Hayes, Paine, and Knowlden, and was inspected by several hundred people, including prominent members of the meat trade, who expressed various opinions on the meat.

An analysis of the opinions expressed by experts, including Lieut.-Col. Dunlop Young (Chief Veterinary Inspector, Port of London), Mr. R. Heywood (Veterinary Officer, Australia), Dr. Moran (Low Temperature Research Station, Cambridge), Mr. Gosling (Meat Purveyor to H.M. the King), and numerous members of the meat trade, revealed the following results:—

(i) The meat represented the finest sample of Australian frozen beef ever sent to Smithfield.

(ii) The Aberdeen, Angus, and Hereford quarters were judged to be of excellent quality and in splendid condition. Their conformation was perfect—small in bone and carrying a wealth of meat—while the texture of the flesh was of the highest standard, with an even distribution of fat. The Shorthorn, while being a first quality bullock of its breed, was considered to be inferior in conformation, and was a little overshadowed by the exceptional quality of the other two.

(iii) The Hereford, on account of its size, weight, and conformation was considered the best from the commercial point of view. From the meat purveyor's stand-point, it was ideal, since from it butchers could meet the requirements of the public for small joints, full fleshed and rich in colour. It compared favorably in these respects with the best home-killed beef and with the very best chilled "baby beef" from the Argentine.

Thawing.—Thawing was carried out in air for three days at 52 deg. F. under atmospheric conditions which were reported as unfavorable. Nevertheless there was an almost complete absence of "drip" from the exposed surfaces during the thawing, and a slight gain in weight, due to condensation of moisture from the air. As a control, quarters of the best chilled Argentine beef were hung alongside, and these showed much more deterioration in the appearance of the fat. The appearance of cut surfaces of the thawed beef showed excellent colour, grain, and distribution of fat.

The following table shows the weights of the beef quarters at the different stages:—

Animal.	Quarter.	Weight before Freezing.	Frozen Weight before Export.	Frozen Weight at Smithfield.	Weight after Thawing.
		lb.	lb.	lb.	lb.
Aberdeen Angus ..	Fore	205	205	205	205
	Hind	218	215	215	216
Hereford	Fore	158	158	158	158
	Hind	176	175	175	176
Shorthorn	Fore	191	190	190	191
	Hind	220	218	218	218

Sale of Beef.—The prices realized on the Smithfield market for the thawed beef were—

Fores—3s. 6½d. per stone (8 lb.)=5¼d. per lb.
Hinds—4s. 8½d. per stone (8 lb.)=7d. per lb.

These prices were 5d. per stone more for the hinds and 4d. more for the fores than the top prices for frozen meat ruling on the day of sale.

Cooking Tests.—With the object of comparing the exported frozen beef with fresh Scotch and with Argentine chilled beef, two cooking tests were arranged as follows:—

1. *Australia House Test.*—The meat chosen for the test held at Australia House consisted of sirloins from (i) the special Australian frozen, (ii) good average quality fresh Scotch, and (iii) chilled Argentine beef.* The frozen beef had been held for an additional two days after completion of thawing.

A similar procedure was adopted to that of the Melbourne test, except that a maximum of 10 marks was allowed for each question included on the form, and the total marks recorded by thirteen guests all unaware of the identity of the samples, were—Special frozen Australian, 374; good fresh Scotch, 367; good chilled Argentine, 356.

After the test the joints were also handed round for the company to see, and the appearance of the Australian was most favorably commented upon.

Portions of the frozen joint used at the luncheon were given to various people to test cold in their own homes, and the opinions expressed were unanimous as to the excellent quality of the beef. In addition, two joints of the Australian frozen beef were cooked and submitted when cold to two West End hotels. In both cases the comments of chefs and kitchen staffs were highly eulogistic as far as the beef was concerned, and the tasters found it difficult to believe that the joints were from frozen beef.

2. *Messrs. Lyons and Co. Test.*—At the suggestion of Dr. Moran, arrangements were made with Messrs. Lyons and Co. for more rigid tests on the lines adopted in previous tests as carried out by this firm on behalf of the British Food Investigation Board.

The cooked portions of beef were tasted by a panel of five expert tasters who were placed on a special diet for a few days prior to the test. The report supplied by Dr. Lampitt, of Messrs. Lyons' laboratories, is given below—

Tasting Tests on Australian Beef.

1. *Method of Test.*—Two joints, topside and sirloin, were cooked from carcasses from the following animals:—

A. Chilled Argentine beef.

B. Special frozen Australian beef.

C. Ordinary frozen Australian beef.

D. Home-killed prime Scotch beef.

The joints were cooked and tasted hot on 29th November, 1929; they were tasted cold on 2nd December, 1929.

Topside, fillet, and flank were tasted on each of A, B, C, and D, except in the case of B, where the flank was so small and nearly all fat that the upper cut was tasted instead.

The results obtained, given in the tables, represent the average obtained by five tasters, marking independently. The tasters were unaware of the identity of each joint.

* It is the recognized practice of Argentine exporters to chill only the best quality beef, and to freeze the second quality.

2. *Aggregate Marks Received on the Two Joints*—

—	Tenderness.		Flavour.		Texture.		Juiciness	
	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.
Maximum	105·0	105·0	60·0	60·0	30·0	30·0	30·0	30·0
D. Prime Scotch, home killed	89·0	89·1	55·2	54·6	24·4	24·5	25·7	23·4
B. Special Australian frozen	87·6	90·6	52·2	48·8	23·0	24·2	24·0	22·5
A. Argentine, chilled ..	83·8	84·9	50·4	44·9	23·0	24·0	25·2	22·6
C. Ordinary Australian, frozen	76·8	79·8	47·6	44·8	19·0	19·6	23·4	19·2

—	Colour.		Fat.		Total.	
	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.
Maximum	30·0	30·0	45·0	45·0	300·0	300·0
D. Prime Scotch, home killed ..	25·6	23·3	41·2	36·7	261·1	251·6
B. Special Australian, frozen ..	24·0	22·4	33·0	32·6	245·8	241·1
A. Argentine, chilled	26·0	23·8	32·8	36·2	241·2	236·4
C. Ordinary Australian, frozen ..	22·6	20·3	29·9	27·6	219·3	211·3

3. *Conclusions.*—From the foregoing results, the following conclusions may be drawn:—

Tenderness.—Hot, the special Australian very nearly equals the prime Scotch and surpasses it when cold. The Argentine meat takes the third place hot and cold, and the ordinary Australian is inferior.

Flavour.—The prime Scotch is best, both hot and cold. The special Australian is second, the Argentine third, and the ordinary Australian worst.

Texture.—The prime Scotch is very nearly equalled by the special Australian and the Argentine. The ordinary Australian is much inferior.

Juiciness.—The prime Scotch beef is best, the Argentine second, the special Australian third, and the ordinary Australian least juicy.

Colour.—The prime Scotch is best, the Argentine next, the special Australian third, and the ordinary Australian worst.

Fat.—This is best in flavour and colour in the prime Scotch; the Argentine and special Australian were alike in taking the second place, and the ordinary Australian last.

The Total Marks show that the prime Scotch home-killed beef is definitely best. The special Australian beef and chilled Argentine beef are very close in second place. The ordinary Australian frozen beef is much inferior.

7. Summary and Conclusions.

1. Chilled and frozen portions of the prime young beef used in this experiment were indistinguishable.

2. The palatability of *prime young Australian frozen beef* was somewhat inferior to prime fresh home-killed Scotch, but superior to prime chilled Argentine beef.

3. The palatability of *good average quality Australian frozen beef* was considerably inferior to that of any of the three samples of prime beef, which were respectively frozen, fresh, and chilled.

4. The *ideal beef* carcass to supply the present demand for "baby beef" at Smithfield appears to be one of about 650 lb. dressed weight, with good conformation, small in the bone, and showing a good percentage of flesh and an even distribution of fat.

Carcasses with these characteristics could be produced from well-bred Hereford or Aberdeen Angus bullocks at about two years' old under conditions of fattening similar to those adopted at the Metropolitan Board of Works Farm, Werribee.

5. The general standard of Australian beef exported could be improved by the introduction of new blood of the desired types, and topping off the cattle with some form of artificial feeding.

8. Acknowledgments.

In conclusion, the Meat Preservation Committee desires to express its appreciation of the co-operation and assistance afforded by the Melbourne and Metropolitan Board of Works, Messrs. W. Angliss and Company, Mr. C. Wilson of Scott's Hotel, Messrs. Hayes, Paine, and Knowlden, Messrs. Lyons and Company, and Dr. Lampitt of the firm's laboratories, Dr. Moran, Lieut.-Col. Dunlop Young, Mr. R. Heywood, and others too numerous to detail.

The Protection of Young Citrus Trees from Frost.

By E. S. West, B.Sc., M.S., Officer in Charge Research Station, Griffith.

The following article is a slightly condensed form of a report recently furnished by Mr. West.—[Ed.]

1. Introduction.

During the winter of the year 1929, an experiment was carried out to test various methods of frost protection for young citrus trees. Owing to the great individual variation in the susceptibility to frost of trees treated in any one particular way, the results were in some respects indefinite; nevertheless results were obtained which seem of sufficient importance to record.

The only known practicable method of preventing frost damage is by orchard heating, but this method is so expensive as to render it doubtful whether such expenditure is profitable. If the chances for the occurrence of many frosts of such intensity are very great, the locality should be considered unsuited to citrus culture. Young citrus trees are very much more susceptible to frost than old trees, and frosts that do no damage to either the fruit or foliage of old trees may completely kill young trees. In almost all citrus-growing districts, during some seasons at least, frosts serious enough to damage young trees occur, so that an economical method of treatment that will prevent or lessen the risk of frost damage to young trees would be of great value.

Many methods of protecting plants from frost are in common use. Methods that depend on covering the plant with an insulating material or with a screening material are suitable for young citrus trees. They include:—

(1) Smudge fires that will cover the orchard with a dense smoke screen, which will intercept the radiant heat given off by the plants and the soil on a frosty night. Such fires are not to be confused with fires used in orchard heating, that are sufficiently numerous to warm the air, and in this way keep up the temperature without the creation of a smoke-screen. Sufficient evidence has not been adduced to show that smudge fires are of any use at all in frost protection, and reliable opinions now deny any benefit due to a smudge(1), so that the use of smudge fires need be considered no further.

(2) Covering part or the whole of the tree with straw, hessian, or some such material. Some protection from frosts should be expected from such treatment. The question arises as to the most efficacious method of covering the tree, and the degree of protection afforded, and whether any ill-effects other than frost result from the treatment. It has been observed that where hessian is wrapped around the stem of the tree, and becomes wet with rain or dew, it may freeze on frosty nights, and actually increase the risk of frost.

(1) Hume, H. H. (1926), *The Cultivation of Citrus Fruits*, p. 337, Macmillan and Co.

(3) Mounding up soil around the stem. Loose soil is such a poor conductor of heat that anything covered with a few inches of soil will certainly be protected from frost in any locality in which citrus trees can be grown. Hume[2] recommends this method, while Coit[3] does not favour the method on account of the danger from gum diseases.

2. Experimental Procedure.

It was decided to try various methods of frost protection on a grove of young Washington Navel trees, planted on the square system in thirteen rows of nine trees each, during the winter of the year 1929. The trees had all been planted out in the spring of the year 1928, most were two years old from the bud at the time of planting, a few were three years old from the bud, and a few one year old from the bud (i.e., were budded autumn 1927).

The following treatments were selected for trial:—

1st.—No protection.

2nd.—Stem protected with hessian. A wire-netting tube about 3 inches in diameter was folded round the stem, and the hessian was wrapped around this tube.

3rd.—Several layers of newspaper were wrapped around the stem and tied with string.

4th.—Clean, loose soil was mounded up round the stem, forming a cone about 1 inch to 18 inches high.

5th.—Hessian sacks (chaff bags) were placed over the trees, the open ends being lightly buried in the soil.

6th.—As in 5th treatment, but the hessian was first dipped in tar and then in sand. This was done to see what effect such complete shading would have on the tree, as in many methods of frost protection most of the sunlight is excluded.

7th.—The trees were completely wrapped in a thick covering of straw, so that no green leaf or stem was visible.

With the 117 trees available, seventeen trees were used for all but two of the seven treatments, and for these two treatments sixteen trees only were available. The different treatments were distributed throughout the block. In the first seven trees of the first seven rows each treatment was distributed at random, with the restriction that each treatment occurred once in each row and each column. The treatments in the next six rows were again filled in at random with the same restriction, so that each treatment but one occurred twice in each column of thirteen trees. The two end trees of each row not allotted treatments thus far (there being nine trees in a row) were then allotted treatments at random, no treatment being allotted twice until all other treatments had been allotted. The field was flat, and soil uniform, and there was no reason to expect more severe frost in one part of the field than another.

(2) Hume, H. H. Loc. Cit.
(3) Coit (1922), *Citrus Fruit*, pp. 245–246, Macmillan and Co.

Three very severe frosts were experienced on the mornings of 12th, 13th, and 14th June. The minimum temperatures in degrees Fahrenheit near this field were as follows:—

—	12th June.	13th June.	14th June.
On lawn (terrestrial)	..	13·8	14·8
On bare soil 2 cms. above ground	22·0	20·7	22·1
1 metre above ground	25·1	23·0	24·7
2 metres above ground	27·1	24·0	26·1

This frost coming in the early winter was responsible for much damage to young citrus, and is the frost that caused the damage here reported.

The protections were removed from the trees on 26th September, 1929, when danger from further frosts was negligible, and the trees were examined for frost damage, and notes were taken. A further inspection was made on 4th December, 1929, to confirm the first observations; the reason for this was that, in cases of frost damage, a tree may look healthy in the spring, but owing to frost injury to the bark on the stem, may succumb soon after active growth commences; on the other hand, some trees look almost completely killed, but buds will burst and the tree recover.

The trees were grouped into four classes according to their condition after the winter, viz.:—

(i) Dead; (ii) dead above the union of the scion and the stock, but stock still alive; (iii) main stem alive but branches dead; (iv) unaffected. (This group includes those trees that have healthy stems, and green and healthy branches. In some cases the trees may have been defoliated, or a few of the smaller shoots may have been killed, but a large proportion of the main branches were alive and green.)

The trees of the first two groups had to be replanted, while in the case of the second two groups it was not necessary to replant.

3. Results Obtained.

Table I. shows the complete data. The number of trees of each age has been shown, and as was to be expected, an inspection of the totals in the bottom row indicates a high positive association between trees one year old when planted and fatal frost injury, and this must therefore be borne in mind in further considering the data.

Table II. summarizes the results for the trees two years old at time of planting, as restricting the data to trees of a uniform age gives a more trustworthy comparison. In this Table, the first two and second two classes have been grouped together, giving two generalized classes, and for each treatment the proportion of trees falling into these two classes is given to the first approximation. The number of trees from which this proportion has been calculated is given in the fourth column.

Compared with the untreated trees it appears that every treatment except covering the tree with hessian, either tar-dressed or otherwise, has afforded some degree of protection; but these two treatments have

been definitely injurious. The most efficient treatments appear to be wrapping the stem with paper, and mounding up the stem with soil. The hessian wrapped round a cylindrical wire frame probably acts as a screen to the stem of the tree, intercepting the radiant heat, while the paper wrapping and soil act as insulating materials retarding the conduction of heat from the tree to the colder exposed surface.

The effects of the mounding with soil were interesting. Table I. shows that ten out of a total of seventeen trees had their branches destroyed, but the main stems protected by the soil survived. It was noticed that, almost without exception, where soil was mounded up around the stem, the bark was destroyed just where the stem emerged from the soil, but a few inches below the soil the stem was quite healthy. It appeared that the injury at this part was more severe and more general than in the other treatments where no soil was mounded up. It would therefore appear that mounding up with soil is a very sure protection against frost for that part of the tree covered with a few inches of soil, but greatly increases the liability to frost of that part emerging from the soil. It is well known that the most susceptible part of the citrus tree to frost is the union of the scion and stock. This has always been explained by the assumption that the union is a naturally weak part of the tree. May it not be that frost injury is greatest at this part because under ordinary conditions it is near the surface of the ground?

It is evident that placing a hessian sack over the tree is in some way injurious, as trees treated in this way suffered more damage from the frost than unprotected trees. The hessian bent the foliage over, and probably gave very little protection to much of the foliage, as the twigs were pressed against the hessian, which was coated with frost crystals on frosty nights. It is possible that a hessian screen, supported on framework over the trees, in such a way that the hessian does not come into contact with the foliage, may give better results, but such an arrangement, even if found to be satisfactory, would probably be too expensive. Although not apparent from the results summarized in Table II., the tarred hessian was even more injurious than the untreated hessian, as it was noticed that the foliage died much sooner under the tarred material. This may have been due either to the more complete shading or to a direct chemical injury. Trees completely enveloped in straw appeared to gain some measure of protection, but as only nine two-year old trees were used in this treatment, no great reliance can be placed on the results.

It is possible that in the case of most protective coverings, the final effect is, broadly, the result of two opposing factors. Checking the falling in temperature of the tissues of the tree is a beneficial factor, while interference with photosynthesis, aeration, and other processes is a detrimental factor, inasmuch as a certain weakening of the tree results, and it would appear from observation that a tree in any way weakened, such as by partial wilting, presence of excess salt in the soil, or by poor nutrition, or mechanical injury, is more susceptible to frost injury; so that the amount of benefit or otherwise that any protection affords is dependent on the relative intensities of these two factors. It has been noticed also that tissue which seemed quite healthy when coverings were removed, died later after exposure. This point, however, requires further investigation. In this connexion Hume[4] advises against completely burying the tree in soil on account of the resultant injury.

(4) Hume, Loc. Cit.

It cannot be said that these results are as yet very conclusive. It is evident that where only small differences exist, a very much larger number of trees should be used than were here available. It is hoped to repeat similar trials in the future; but certain difficulties exist. Firstly, an orchard having recently planted uniform trees, and situated on level land free from any influences likely to cause differences in frost liability in different parts of the orchard, is required, and such an orchard is very difficult to find. Secondly, the success of the trial will depend on whether frosts sufficiently severe to do much damage occur, and after all, the chances are of course against this in a citrus-growing district.

4. Summary.

A trial was made of different methods of protecting young orange trees from frost.

It appeared that—

(1) Wrapping a few thicknesses of paper round the stem gave very effective protection.

(2) Mounding soil up round the stem was effective protection to the stem, but increased the injury to the branches.

(3) Protecting the stem with a cylindrical wire-netting frame 3 inches in diameter covered with hessian was less effective.

(4) Placing a hessian bag either tarred or not tarred over the tree was distinctly detrimental.

It is felt, however, that further trials could be carried out with advantage.

TABLE I.

Age of Tree when Planted.	Dead.			Dead to Bud Union.			Stem Alive.			Unaffected.			Total.
	1 yr.	2 yrs.	3 yrs.	1 yr.	2 yrs.	3 yrs.	1 yr.	2 yrs.	3 yrs.	1 yr.	2 yrs.	3 yrs.	
1. No protection ..	3	3	3	..	2	..	..	1	..	..	5	..	17
2. Hessian over Wire	3	1	..	..	2	..	..	..	..	2	8	1	17
3. Paper round Stem	1	1	..	..	1	..	..	..	..	..	12	1	16
4. Mound of Soil ..	..	..	1	1	1	..	2	8	..	..	4	..	17
5. Hessian over Tree	1	8	..	2	5	..	..	..	..	..	1	..	17
6. Tarred Hessian over Tree ..	2	7	2	..	3	1	..	2	..	..	..	..	17
7. Straw over Tree	5	3	..	..	..	..	..	2	1	..	4	1	16
Totals ..	15	23	6	3	14	1	2	13	1	2	34	3	117

TABLE II.

—	Dead to Union.	Stem Alive.	Number.
	Proportion of Total.		
No Treatment	·5	·5	11
Hessian over Wire	·3	·7	11
Paper round Stem	·1	·9	14
Mound of Soil	·1	·9	13
Hessian over Tree	·9	·1	14
Tarred Hessian over Tree	·8	·2	12
Straw over Tree	·3	·7	9

Fifteenth International Geological Congress, South Africa, 1929.

By Professor H. C. Richards, D.Sc., University of Queensland.

Professor Richards was the official representative of the Commonwealth at the above Congress, which was held in South Africa during the months of July and August, 1929. On his return to Australia, he furnished the Prime Minister's Department with a report on the Congress. The article that follows is constituted of the more important parts of that report.—Ed.

The first International Geological Congress was held in Paris 51 years ago, while the one preceding that in South Africa took place in Spain in 1926. The next Congress will be held in the United States of America three years hence. As the time will arrive in due course when the Commonwealth Government will be expected to issue an invitation for the Congress to be held within its borders, some particulars of the recent Congress may be of advantage on some future occasion.

The XVth Congress was held in South Africa as the result of a unanimous wish of the delegates at the Madrid meeting in 1926, and Dr. A. W. Rogers, F.R.S., the Director of the Geological Survey of the Union of South Africa, was asked to make representations to his Government for the issue of invitations to the Governments and Geological and Mining Institutions and Universities throughout the world. The total membership of the Congress was 534, of which 320 were in attendance. Of this number, 230 geologists came from overseas and represented 45 different nationalities. There were present 74 official delegates, representative of 34 different Governments. The official languages were six in number, viz., English, Afrikaans, French, Spanish, German, and Italian. English, French, and German were mainly used throughout the proceedings.

Financial and other help was extended to the Congress by the Union Government of South Africa, the Witwatersrand Chamber of Mines, the Gold Producers' Committee, the Collieries Committee of the Chamber of Mines, the De Beers Consolidated Mines, the Becker and Ohlthaver Investment Trust Company, South African Townships, the Town Councils of Pretoria and Kimberley, the Pretoria Chamber of Commerce, and several private donors. Travelling facilities, especially in the form of rebates up to 20 per cent. on the usual rates, were extended by the overseas shipping companies, and up to 50 per cent. by the South African and Rhodesian railways, to all members, official or otherwise, who attended the Congress.

The business sessions of the meeting took place in Pretoria, and lasted from Monday, 29th July, till Wednesday, 7th August. The papers submitted were supposed to be restricted to the following six topics, but a large number dealing with other matters were presented and were grouped under "General":—(i) Magmatic differentiation (nine papers); (ii) glacial periods (nine papers); (iii) Karroo System (seventeen papers); (iv) genesis of petroleum (four papers); (v) work of micro-organisms (two papers); (vi) rift valleys (six papers); general (50 papers).

In addition to the above papers, several very important discussions on magmatic differentiation, the Gondwana System, and the rift valleys were held, abstracts of which, along with the papers, will be printed in the Compte Rendu of the Congress.

The compilation of the "Gold Resources of the World" from the accounts furnished from the various countries will be a special feature of this Compte Rendu; the various documents from Australia pertaining to this matter were duly handed over to the Honorary Secretary.

The Council of the Congress was comprised of all official delegates, while the Government delegates were made Vice-Presidents, and at meetings of this body the following important matters were considered:—

(1) The compilation of the "Gold Resources of the World."

(2) The report of the Committee preparing an International Geological Map of the World.

(3) The appointment of a Committee to consider the distribution of the Karroo System or its equivalent throughout the world.

(4) The award of the Prix Spendiaroff.

(5) The consideration of a proposal to establish an Institute of Mining Economics in Berlin.

(6) The selection of the country for the next Congress.

With respect to (5), Dr. Krusch, the head of the Prussian Geological Survey, placed before the Council a proposal to establish at Berlin an International Institute of Mining Economics; the aims of the institution to be—(*a*) Preparation of a dictionary of standard terms; (*b*) standardization of statistical methods relating to ore reserves, &c.; (*c*) publication of Annual Reports; and (*d*) preparation and publication of maps of ore deposits of the world on scale of 1:5,000,000. The matter was fully discussed amongst members before the actual motion was placed before the Council, and eventually an amendment by Sir John Flett, F.R.S., Director of the British Geological Survey, seconded by M. Le Prince Rinquet, of France, was carried that—

"Action in this matter be delayed until the delegates submit the proposals to their responsible authorities in their respective countries."

Two official invitations to hold the next Congress were placed before the Council—

(*a*) from the United Socialistic Soviet Republics (Russia);

(*b*) from the United States of America.

The Vth Congress was held in the United States of America in 1891 and the VIIth in Russia in 1897. Eventually, it was decided to accept the invitation of the United States of America for 1932, and to ask the Council of the next Congress to give sympathetic consideration to the claim of the United Socialistic Soviet Republics for the succeeding meeting.

As most members attending the Congress were not familiar with South African geology, and as there are so many mining activities of great importance going on in the sub-continent, a long list of 23 excursions was drawn up. These provided for the general geologist, the stratigrapher, and paleontologist, also for the economic and mining

geologist. Excellently-prepared guide-books relating to each excursion were printed and issued to the members of the excursion. The perfect organization of these excursions, some of which lasted several days—one of fourteen days—thereby involving much train and motor car travelling, enabled members to gain the maximum advantage from their visit to South Africa. Members were given full opportunity of seeing and gaining information relating to the gold, platinum, diamond, asbestos, chromite, manganese, copper, zinc, lead, and coal mines, &c.

The part which high-skilled prospecting by properly-trained geologists has played in developing the mining industry in so far as gold, platinum, manganese, chromite, asbestos, copper, and coal are concerned is patent to any one visiting these regions. The work on the platinum fields of Lydenburg and Rustenburg, in the Transvaal, has been an absolute triumph for the Economic Geologist, Dr. Merensky, and the same may be claimed for the geologists associated with the Anglo-American Corporation and the subsidiary companies in Northern Rhodesia.

The Commonwealth Government, in sending an official delegate to this Congress, did only what was expected of her by the other countries of any importance in the world. Apparently in the past Australia has only on rare occasions been represented by any geologist, and I feel that I must urge strongly that at the next meeting in the United States of America one or more representatives from Australia be sent.

When one meets the highly-placed geological officials from the Geological Surveys, Universities, and Mining Schools in about 45 different countries and converses with them as to how the science of geology is being applied to industry, mining and otherwise, in their countries, one feels that in Australia in some respects we are not abreast of the times, and are not achieving as much from this branch of science as are many other countries. The Governments, both Federal and State, must have it impressed upon them that at the present time Australia is perhaps not doing in a geological way what other countries are doing, and the question as to whether in some respects we are not retrogressing is, unfortunately, very hard to deny.

The present development of such a mine as the Roan Antelope copper property in Northern Rhodesia is an excellent example of the advantages gained by applying science to industry. By the expenditure of about £250,000 in field geological work, in drilling, in pitting, and in metallurgical investigations, a copper-bearing deposit, containing at least £140,000,000 worth of copper at the present market value, has been located in a condition and form very suitable for mining and metallurgical treatment. The plant for milling and smelting will cost some £3,000,000, and a programme of work over a period of 25 to 30 years will be laid down. A pilot plant has amply demonstrated that the ore may be concentrated by flotation methods at low cost, and the directors of the company may now enter upon their task as a straight-out business concern and not as a gamble, as has so often been the case in mining.

In Australia, as elsewhere, most of the high-grade deposits of gold and the base metals have been discovered and worked, so that the mining industry of the future will deal more with the medium and low-grade propositions, which must be operated on a large scale. Frequently, the outcrops of these deposits—as in the case of the Black Star lead-zinc

lode and at Mount Isa, Queensland, or the copper-bearing lode of Northern Rhodesia—are not at all attractive to the ordinary or old-time prospector.

A sound knowledge of structural and field geology, coupled with mineralogical experience, is necessary in order to appreciate the significance of these outcrops. Consequently, one needs to encourage capital by granting large areas with extensive rights, and so enable the companies interested to utilize a staff of highly-trained field geologists operating in conjunction with drills and with pitting teams.

While much is expected of geophysical methods of prospecting, the necessity for sound geological work in connexion with these methods will always be felt. When one realizes the necessary relationship between a proper knowledge of Australian geology and the full development of our mining, pastoral, and agricultural industries, one wishes that more encouragement could be given to that science.

Either the Commonwealth should establish a Federal Geological Survey, or the various States should be urged to strengthen their organizations, and by means of relatively frequent meetings, such as the Interstate Geological Congress, arrange for as much co-ordination as possible between themselves on matters affecting more than one State.

Before there can be a full and proper application of the science of geology to the industries of Australia as is at present being done in some of the European countries, Japan, and the United States of America, some such development as indicated above must take place, and the Commonwealth Government should be urged to play its part.

May I, in conclusion, express the hope that at the 1932 Congress in the United States of America there will be present a delegation of several members from Australia instead of the sole representative as on this recent occasion? The importance of the International Geological Congress is, apparently, more keenly appreciated by virtually all other countries than by Australia, and much more serious attention by Australia is warranted.

The International Congress of Forestry Experimental Stations.

By S. Garthside, M.Sc., B.Sc.Agr.

Mr. Garthside left Australia some three years ago as a trainee under the Science and Industry Endowment Fund. Whilst undergoing his training under the provisions of that Fund, he made a special study of forest entomology. He is now an officer of the Council attached to the Division of Economic Entomology, and located at Farnham Royal, England. Although for the time being his main activity is the search for European insects likely to be of value in connexion with the control of St. Johns wort in Australia, it was thought desirable to have him attend the 7th International Congress of Forestry Experimental Stations, which included a section on forest entomology, and which was held in Sweden in July, 1929. On his return from the Congress, he furnished a full report, portions of which are printed below.—[Ed.]

1. Entomology Section.

The first paper read to the Entomology Section was by Mr. Hubault. It was about bacterial parasites of caterpillars, and was followed by considerable discussion of the whole subject, various members giving their experiences with such organisms. It seems that these have often been advocated as methods of controlling outbreaks of various caterpillars, &c., but no one has apparently heard of any real success, and thus they are rarely, if ever, seriously considered in this respect.

Dr. Trägårdh next gave a rather interesting paper on methods of investigating the fauna of dying trees. This was more particularly a consideration of methods of pictorially representing the fauna, or succession of faunas of such trees, and followed very much along the lines of his paper in the *Bull. Ent. Res.*, XVI., Pt. 2, p. 169, Oct., 1925. Spruces he found died from the top and from the bottom at the same time; thus there is a sequence of insects from the top downwards, and the same sequence from the bottom upwards, the two meeting somewhere about the middle. He also found that a very important factor in the attack of various species was the thickness of the bark.

Professor Komarek read two papers, but neither was of a technical nature. In the first, he stressed the need for the complete separation of forest entomology from forest botany and forest pathology. In the second, he pointed out that the fight against insects in the forests always involves too much expense to be undertaken by private owners; and thus he suggested that private concerns should pay certain sums towards the work, such money to be then used for protective measures and investigational work.

Dr. Spessivtseff, in his paper on the study of bark beetles, made an appeal for greater co-operation amongst the workers in this important group of insects. This was needed for many reasons, amongst which he included the great natural difficulties presented by the group, the lack of satisfactory keys, and the description of new species in remote journals, such descriptions being made only from a few individuals, and not given in sufficient detail.

The question of the multitude of languages used, and the wide diversity of journals publishing forest entomological papers came up in Dr. Butowitsch's paper, in which he proposed the establishment of a Review of Forest Entomology. It was decided by the Section, that further

consideration of this matter should be deferred until the next International Entomological Congress in Paris, in 1932, when there would be a larger gathering of those interested in such a project. In the meantime it was thought best simply to make the matter as widely known as possible, so that when it was considered, the various workers would have had time to have discussed it beforehand.

Considerable discussion followed another paper by Prof. Komarek on the changing of the food habits of insects. Dr. Trägårdh instanced a case in Sweden of a species of *Dendroctenus,* occurring on spruce. The spruce stand was clean-cut, so the insect transferred its activities to adjacent pine. However, it did not succeed in establishing itself, as the eggs would not hatch, but the feeding of the adults, and the deposition of the eggs, caused considerable damage to the trees, and even killed some. Prof. Komarek then mentioned a case in Czecho-Slovakia, where spruce had been planted on an area that had previously been under pine. However, in this case the bark beetles did not come to the spruce, as their existence seemed to be definitely connected with rainfall, for they are not found in areas with more than 800 mm. of rainfall. This is also approximately the lower line for spruce in that region, and thus these trees escaped the bettles entirely.

In another paper, Professor Komarek outlined his experiences with aeroplane dusting and enumerated several points which must be considered in such dusting. One must determine for which insects dusting with arsenic is successful, at what stage it is best to use it, and which arsenate is more suitable, calcium or lead. In Europe, attention has been paid to the killing of bees by dusting operations, and, at times, compensation has had to be paid to the owners. Dr. Kozikowski stated that, in Poland, they have found it better to dust from the ground with motors than from aeroplanes, the apparatus costing from 800 to 1,000 German marks.

The complete proceedings of the Congress, including the papers read before the various sections, are in the course of preparation, and applications for them should be addressed to the Secretary of the Congress, Sven Petrini, Experimentalfältet, Stockholm, Sweden.

2. General Forestry Excursions.

In connexion with the Congress proper, the Swedish forestry authorities had arranged a series of excursions. The first was for the week previous to the meetings in Stockholm. It commenced at Malmo, in the South of Sweden, and included the more important parts of the Southern counties, with the idea of acquainting members participating in it with the forestry conditions and problems of that section of the country.

On the Wednesday of the week of the meetings in Stockholm, there was arranged a full day excursion for all members to Katrineholm and the surrounding district, with the object of studying the forestry conditions in Södermanland, a province in Central Sweden.

Following the meetings at Stockholm, there was another week's excursion through the forests of Northern Sweden (Norrland). The first day of the excursion was spent in motoring round to various plots in the Oxbole State Forest, which had been set up to study the natural regeneration of various areas after fire and after cuttings. The following day a most interesting trip was made down the river Ångermanälven to Sandslån. This river is one of the largest in Norrland, and is besides

a very important main rafting water course. At Sandslån, there is a large log-sorting boom. The logs of some 88 to 90 owners are cut in the forests, partly barked and branded, and then put in the river to be carried down to this boom, where they collect in either of four large funnels formed by floating logs chained together. From the funnel, they pass along channels on either side of which are scores of men watching each for logs with a particular brand on them. The logs are drawn aside into their correct compartment, and there further divided up into those for lumber, those for paper and pulp, and those for firewood. When sufficient of one classification are secured, they are released at the other end of the compartment and floated down to a large apparatus for compacting them together, and tying them up into large rafts. The rafts are then connected together with wire cables, and a tug tows them to the mill or other destination. They anticipate handling in this way at this boom this present year in all over 18,000,000 logs. Most of the timber floated is coniferous.

3. Forest Entomological Excursion.

The general forestry tour of Northern Sweden ended at Åre, on Saturday evening, 3rd August, but there remained, what was to me, one of the main items of the visit, a special forest entomological tour, under the direction of Dr. Trägårdh. Nine of us, representing in all eight different countries, participated in this excursion, which started on the Sunday evening, travelling all that night. The following day we were at Hofors, and were there the guests for the day of the S.K.F. Steel Company, who are famous for their ball-bearing steel. The steel companies are some of the largest forest owners in Sweden. Years ago they were granted huge tracts of forest lands from which to secure the wood to be burnt to charcoal for adding to the pig-iron to convert it to steel. Only the small-sized material is placed on the charcoal pile, the other being sent to the mill as lumber or else for paper-pulp making. During the day we visited the Hofors forests. There we were able to see the work of *Ips typographus* in spruce. This bark beetle occurs regularly in Sweden, though it is not as bad as in Central Europe. After heavy snows, it is found that some trees get broken down, and then form breeding grounds for the beetles. The foresters are always on the look out for such trees, and when they find one they cut and peel it, so as to prevent the beetles from breeding any further. Sometimes the beetles attack where there has been no damage, in which case it is hard to say what has been the cause. Such cases are often in small open spaces. In one area visited, there had been a small outbreak of this species. It had been traced through several years, so that now, one could say that for every tree attacked the first year, there would be three in the second year, but in the third year, instead of nine, as might be expected, there would be only one. It had been found that, in the third year, an enormous number of larvae would be parasitized. Then in the fourth year, all the remaining beetles would leave the area and find some fresh spot. Thus local outbreaks are small and never extensive. It has also been found that a fungus attacks the larvae after they have made the pupal chamber. This fungus seems to be present in some years and absent in others. In another area visited, there was a small outbreak last year, involving in all about 100 trees. These were located by the browning of the foliage. They were cut and peeled immediately. However, a few that were showing little if any discolouration of the

foliage last year were missed, but are easily seen this year. These, this year, also have some secondary pests, such as *Pityophthorus micrographus* and *Hylurgus paliatus*. *Pityophthorus tragardhi* was also found in the branches, whilst *Xyloterus lineatus* was seen boring into the wood after the bark beetles.

That evening we went to Orsa. This is only a very small town, but it owns very extensive forest areas. The following day we were shown over these by the forester in charge, and had an opportunity of seeing some of his control work against bark beetles. The forest had remained untouched by man until 1887, when cutting on a large scale commenced. All trees with a diameter at breast height of over 14 inches were cut. As a result, large quantities of trash were left around, and consequently bark beetles became very bad and whole hillsides would look reddish with dead and dying trees. The possibility of such attacks had never been considered. Now, however, with present-day management, danger of attacks of this nature in future is small, as outbreaks are very soon located. The trees are now from 250 to 300 years old.

In Northern Sweden, June and July are the dry months, when there is danger of forest fires. At that time the pine beetles have finished their breeding, and thus do not get into scorched or damaged trees until the following year. However, the pine sawyer (*Monochamus*) is about at that time. Usually after a forest fire, owners leave the scorched timber until the winter time and then cut and remove it. In the meantime *Monochamus* has come in. The procedure that should be adopted is to examine the trees a few weeks after the fire. If the crown is more than one half green, then there is no fear of pine beetles. An area was visited where a fire had been lit at the end of May this year, to burn a lot of rubbish. It became a little too strong and scorched a few trees. They were thus damaged earlier than would have been the case from a natural forest fire, and so might be expected to contain pine beetles. A few were cut down for us to examine, and the following beetles were found:—*Ips acuminatus, I. sexdentatus, Monochamus* sp., and *Pissodes* spp. (*pini* and others).

In another section of the Orsa forests a region was seen where trap trees had been set up. It had been found that some bark beetles (e.g., *Myelophilus piniperda*) are easily caught in trap trees, whilst others (e.g., *Ips typographus*) are much more difficult. Standing trap trees are found to be better than cut ones, for the simple reason that they secure beetles swarming in all regions, whether high or low. Such trap trees must be prepared in the middle of the year before being cut. The preparation consists of cutting a ring of the bark completely away—"ringbarking." Felled trap trees should also be used with the branches on them. When an area is to be clear-cut, a series of these trap trees are set up the previous year. Then later these trees are examined to see when all the eggs have commenced their development. Then the trap trees are cut down and barked. When the bark is removed in this way and exposed, the larvae are killed. Sometimes, under certain weather conditions, *Ips typographus* swarms at high and not at low levels, in which case it is only the standing trees which will be attacked.

Paper from Eucalypts: Its Development in Australia.

Now that the production of paper from Australian timbers is apparently about to commence on a comparatively large commercial scale, an account of the steps leading up to that development is perhaps appropriate. The matter is also of interest in that the research work carried out in Australia has led to revolutionary practices in paper-making countries like America, and to the destruction of an old fallacy, viz., that only the longer fibred woods (from coniferous trees) could be used to make good quality papers.

Previous attempts to use hardwoods, in which class the Australian eucalypts of course fall, resulted in low yields of difficultly bleachable pulp which was also believed to yield only weak sheets because of the shortness of the fibres. Hardwood fibres are about 1 mm. in length, whereas those of the softwoods are from two to three times as long. It has, however, now been demonstrated that, by suitable treatment, hardwoods can be made to give high yields of easy bleaching pulp, which again, by appropriate conditions of treatment, can be converted into high-class papers of almost any quality.

The workers in Australia who unravelled the problem of hardwood paper began with no knowledge of the industry, and an open mind which had no prejudice to overcome. In the process of paper-making, the wood is chipped and subjected to the action of certain chemicals in order to dissolve those substances which bind the tiny fibres into hard bundles. It was easy for the idea to grow that hardwood chips needed more severe chemical treatment than softwoods. As a matter of fact the reverse is, generally speaking, the case, and it was the failure to recognize this that led to poor results in early experiments. The paper-making industries of the world had been developed in softwood countries, and a technique gradually grew up suited to such woods. Experts failed to modify this technique in the right direction when trying hardwoods.

From time to time, various workers in Australia have examined a variety of timbers for their paper-making qualities. The investigations in almost all cases consisted of a determination of the percentage of cellulose in the material, and in the measurement of the fibres. In a few cases, material was pulped and made into sheets of paper. In New South Wales, a bulk trial was made with several tons of wood, but the paper made was of no value. Because of these experiments, several people have claimed priority in the manufacture of paper from hardwoods. These claims are not in any sense justified. In no case was any attempt made to modify the recognized processes of pulping, beating, and bleaching so as to give high yields of easy bleaching pulp that could be made into high quality papers, nor was any investigation made as to the comparative economics of the processes with hard as against soft woods. Until both these steps were taken, it was not possible to lay the foundations of a paper-making industry.

In 1914, the Tasmanian Government brought out Mr. Henry Surface of the United States Forest Service in order that he might test Tasmanian woods. He condemned them as paper-making materials. In 1916, the first attempt at a comprehensive attack on the hardwood paper problem was begun by Mr. I. H. Boas at the Perth Technical

School as a result of a suggestion made to him by M. Mathey, Conservator of Forests at Dijon, through Mr. Lane-Poole, then Conservator of Forests in Western Australia. At that time, hardwoods were regarded as practically of no value for paper-making. At first, trials were restricted to the soda process, and by suitable modifications of existing practice, it was found that surprisingly high yields of easy bleaching pulp could be obtained. The work was continued under the auspices of the former Advisory Council of Science and Industry, with the assistance of Mr. L. R. Benjamin, until it became clear that the main factor preventing the use of hardwoods was prejudice.

In 1919, Mr. Boas attempted to interest paper makers in various countries in these trials with no success, though the facts were easily verifiable. The one exception to this general condemnation was M. Vidal, of the Paper School at Grenoble in France, who had himself begun experiments on immature bluegum (*Eucalyptus globulus*) grown in the South of France.

In 1920, with the aid of a model paper-making machine purchased with a grant made by the newspapers of Western Australia, and of a model beater loaned by the Australasian Paper and Pulp Co., the work was continued in the former Forest Products Laboratory at Perth. In 1921, when Mr. Boas resigned, Mr. Benjamin carried on the work, and continued under the reconstituted Institute of Science and Industry, and later under the present Council for Scientific and Industrial Research. To Mr. Benjamin and his co-workers is due the credit for developing the processes technically up to the semi-commercial scale until all the ordinary methods of pulping had been demonstrated. As is perhaps well known, all these investigations have now been taken over by the Tasmanian Paper Pty. Ltd.—a concern established by Broken Hill mining interests, to engage in the commercial production of paper in Australia.

Reports of all this work were sent to various research stations abroad, and some of these confirmed the results obtained in Australia. The Forest Products Laboratory at Madison, Wisconsin, in testing eucalypt timbers from Brazil in 1927, used the schedules evolved by Benjamin. In 1928, the same laboratory used his schedule in a co-operative investigation with officers of the New Zealand Forest Service in testing New Zealand woods. Meanwhile, the paper position in the United States had become very serious, and larger quantities of Canadian pulp had to be imported. This turned the American paper-makers' thoughts to hardwoods, and here the work done in Australia came in and showed the way. American investigators at Madison went still further and developed the latest semi-chemical process and the use of the rod mill in beating. These made a tremendous step forward in the hardwood paper industry, which is now established elsewhere on a firm basis, and which is going through its initial stages in Australia at the present time.

That the work begun in 1916 did not reach its commercial development until about 1928 is but an instance of the difficulties attendant on the determination of the technical and economic basis of an industry which needs the expenditure of millions of pounds of capital before it can be established.

PLATE 1.

THE LATE PROFESSOR T. BRAILSFORD ROBERTSON.

C.15801.

PLATE 2.

FLYING FOX INVESTIGATIONS (See page 8).

FIGURE 1.—Flight of flying foxes (*Pt. scapulatus*) disturbed from mangroves at Burnett Heads, Queensland.

FIGURE 2.—Full grown male of *Pt. gouldi*.

PLATE 3.

FLYING FOX INVESTIGATIONS.

FIGURE 3.—View in a camp of *Pt. poliocephalus* near Tweed Heads, New South Wales.

FIGURE 4.—*Pt. gouldi* in the characteristic resting position.

PLATE 4.

FREEZING AND CHILLING OF AUSTRALIAN BEEF.

FIG. 1.—SIDE FROM POLLED ANGUS.
Taken in Australia shortly after slaughter.

FIG. 2.—SIDE FROM HEREFORD.
Taken in Australia shortly after slaughter.

NOTES.

Back Numbers of Periodicals.

With the extension of its activities, the Council is frequently faced with a shortage of literature with which to assist its more isolated groups of investigators and individual research workers. It is difficult to overcome this comparative isolation, for many of the problems under investigation need study in the localities in which they occur. Climatic factors also exert an effect. It has become quite obvious that the scientific staff of the Council can never be located all in one central place if efficient work is to be carried out in all its various investigations.

To meet that position so far as literature is concerned, it is proposed, *inter alia,* to build up duplicate sets of all periodicals of scientific interest published in Australia. Gifts of copies of the publications (including journals) of the State Departments of Agriculture, of the Linnean Society of New South Wales, of the Royal Societies in each State and of the State museums, more particularly the early issues, would be much appreciated. If any reader, who has any such publications that he would like to present to the Council, either single volumes or sets running over a number of years, would communicate with the librarian of the Council, arrangements would gladly be made for their cartage, &c.

Council's Laboratories at Canberra.

The laboratory buildings at Canberra for the Division of Economic Entomology (see this Journal, Vol. 2 (1929), p. 181) were completed in December, 1929. The Division moved into them on the 18th November, and was followed some three or four weeks later by the Division of Economic Botany. The latter Division will share the laboratories temporarily pending the erection of its own buildings alongside. It is probable that the laboratories will be officially opened by the Prime Minister on about the 12th of March, shortly after Parliament next meets.

The contract for the erection of the laboratories of the Division of Economic Botany has just been let. These buildings will practically be a replica of the buildings of the Division of Economic Entomology, and it is expected that their total erected cost will be in the neighbourhood of £20,000.

Australian Rain-Forest Trees.

At the end of 1927, action was taken by the Council for Scientific and Industrial Research, the Australian National Research Council, the Commonwealth Meteorologist, the Commonwealth Inspector-General of Forests and the Director of the Commonwealth Solar Observatory to secure funds for the publication of Australian work of high scientific merit which was in danger of being lost to subsequent workers owing to the impossibility of securing its publication through normal

channels. It was pointed out that the resources of scientific societies in Australia were usually inadequate for the printing of extensive work, while on account of their restricted appeal, highly technical works were usually unattractive to commercial publishing houses. A recommendation was forwarded to the Prime Minister's Department that a sum of money be provided annually on the Estimates to cover the cost of printing and publishing highly meritorious scientific memoirs which otherwise would not become generally available. The Commonwealth Government gave its approval to the proposal and a small Executive Committee was appointed to administer the fund, the members being Dr. A. C. D. Rivett, Mr. H. J. Sheehan (Federal Treasury), and Dr. W. G. Duffield (Australian National Research Council). On Dr. Duffield's death, his place was taken by Dr. W. G. Woolnough (Geological Adviser to the Commonwealth Government).

The first work to be accepted for publication was by Dr. Kidson on meteorological observations of the First Shackleton Expedition, but the first to appear from the press is "Australian Rain-Forest Trees" by Mr. W. D. Francis, Assistant Botanist of the Department of Agriculture and Stock in Queensland. This book is printed and published by Mr. A. J. Cumming, Government Printer, Brisbane, and reflects the utmost credit on his staff. A certain number of copies have been made available free of cost to leading scientific institutions, and the book is now available to the general public at a price of 10s., which is below the cost of production. There are 226 full page plates in the work, which runs altogether to 347 pages. The distribution of it will be carried out by the Council for Scientific and Industrial Research, and orders should be sent addressed to the Secretary, 314 Albert-street, East Melbourne.

Lucerne Flea (Clover Springtail) in Tasmania.

Dr. Tillyard has recently visited Tasmania, where he accompanied the Director of the Department of Agriculture on a tour of the areas infested with lucerne flea, taking in certain ragwort and St. John's wort areas on the way. He has furnished a report on the lucerne flea (clover springtail) in which he points out that the insect is not a flea at all but belongs to the order Collembola or Springtails; also that it is not in any way specially attached to lucerne but is much more markedly a pest of clovers in general. He accordingly regards the name "lucerne flea" as a misnomer and has suggested its replacement by the term "clover springtail."

He states that the pest was apparently introduced into Tasmania some seven years ago, in three separate consignments of unclean seed of subterranean clover imported from South Australia. The pest was not brought to the notice of the Department of Agriculture until June of the present year. Three localities—Forth, Gawler and Stanley—are now known to be affected seriously.

As to methods of control, Dr. Tillyard suggests a preliminary survey and delimitation of the affected areas followed by a programme of spraying and starvation (that could be brought about by fallowing).

The National Research Council, Canada—Recent Developments.

Details of a recent decision that well exemplifies the important place in national affairs nowadays given by Governments to the scientific investigation of national problems, have recently been forthcoming from Canada.

For some twelve years or more, the Federal Government there has been making an annual grant to the National Research Council, but the size of the grant (about £35,000) precluded any extensive developments, and the activities of the Council were mainly centred in the co-ordination of research work through co-operative investigations and Committees, in the making of small grants to qualified investigators working in laboratories belonging to previously existing organizations, and in the training of investigators by the awarding of post-graduate and travelling scholarships.

Within the last year or so, however, the Federal Government has decided to augment its annual grant by almost 100 per cent. with a view to enabling the Council to carry out that particular work in a more comprehensive way. In addition, it has undertaken to provide the Council with a central laboratory at Ottawa, the cost of erection and equipment of which are estimated to reach no less than £600,000.

An important purpose of these laboratories will be to provide Canada with an organization having similar functions to the United States Bureau of Standards and the Mellon Institute. In 1928, the Honorable James Malcolm, Minister of Trade and Commerce, and Dr. H. F. Tory, President of the National Research Council, visited the United States and paid particular attention to these organizations with a view to acquiring information of value to those responsible for the plans of the new Canadian laboratories.

Detailed plans and specifications of the laboratories were prepared some time ago, and tenders for the erection of the building closed in December, 1929. It is expected that the erection and equipment will be completed some two years later. The buildings will resemble in shape a squared figure eight, there being two large interior courts. A lecture theatre and library will be situated in the central part of the building, immediately back of the main entrance. Engineering and heavy testing laboratories will be situated at the back of the building with suitable entrances and facilities, the balance of the building being divided up into laboratories for researches in chemistry, physics, and biology, with the exception of the space set apart on the main floor of the building for the executive offices and board room of the National Research Council. Adequate provision will be made also in the large rooms of the various entrances for committee rooms for staff conferences, &c. Provision will also be made on the roof of the building for the housing of animals. Two large exhibition halls are being provided on the ground floor in the interior courts.

The work that will be carried out in the laboratories will not be solely of a similar nature to that of the United States Bureau of Standards and the Mellon Institute. In fact, it is obvious that they will play an important part in the investigation of various national and essentially Canadian problems. The functions of the Council include the following:—

"(i) The promotion of the utilization of the natural resources of Canada.

(ii) Researches with the object of improving the technical processes and methods used in the industries of Canada and of discovering processes and methods which may promote the expansion of existing or the development of new industries.

(iii) Researches with a view to utilizing the waste products of said industries.

(iv) The investigation and determination of standards and methods of measurement, including length, volume, weight, mass, capacity, time, heat, light, electricity, magnetism and other forms of energy; and the determination of physical constants and fundamental properties of matter.

(v) The standardization and certification of the scientific and technical apparatus and instruments for the Government's service and for use in the industries of Canada; and the determination of the standards of quality of the materials used in the construction of public works and of the supplies used in the various branches of the Government's service.

(vi) The investigation and standardization at the request of any of the industries of Canada of the materials which are or may be used in or the products of the industries making such a request.

(vii) Researches the object of which is to improve conditions in agriculture."

Pending the erection of the new laboratories, the Council has been provided with temporary laboratory accommodation, and it is accordingly proceeding with the appointment of the necessary extra staff. Dr. G. F. Whitby, formerly Professor of Chemistry at McGill University, has recently been appointed as Director of the Chemistry Division of the laboratories; Dr. R. W. Boyle, formerly Dean of the Faculty of Science and head of the Department of Physics at the University of Alberta has accepted appointment as Director of the Division of Physics and Engineering Physics; and Dr. Robert Newton, head of the Department of Field Crops at the University of Alberta, has been appointed on a part-time basis as Acting-Director of the Division of Biology. In addition to the foregoing, Professor J. H. Parkin, formerly of the Department of Mechanical Engineering at the University of Toronto, has been appointed Assistant-Director in the Division of Physics and Engineering Physics, and will be in charge of aeronautical research. For many years past he has had charge of the aeronautical research work carried out in the wind tunnel at the University of Toronto. Other appointments to the scientific staff are pending.

National Research in Belgium.

A pamphlet in reference to the recently formed Belgian "Fonds National de la Recherche Scientifique" has just been received by the Council. The following paragraphs are based on the information it contains:—

The subscriptions to the Fund have now reached 111,000,000 francs (£700,000). The origin of the movement to create the Fund

arose in October, 1927, when His Majesty the King of the Belgians, in a public announcement, referred to the difficulties which the more important scientific institutions of the country were experiencing. Thus encouraged, the Universities of Brussels and of Louvain convened a conference with a view to educating public opinion to the danger of continuing the neglect of the scientific examination of national problems.

The conference was attended by the majority of the intellectual leaders of the country and led to the creation of the above mentioned Fund. Within three months, thanks to generous contributions from banks, industry, commerce and individuals, no less than 100,000,000 francs were obtained. On the 2nd June, 1928, a Royal decree legally constituted the existence of the Fund, by which time it had increased by another 11,000,000 francs.

Naturally, in a total so considerable, some very large individual contributions were made. Chief among these were contributions totalling 25,000,000 francs from the Solvay family and firm, 11,000,000 francs from the Société Generale de Belgique, 5,000,000 francs each from the banks (National de Belgique, d'Outremer, de Bruxelles, and d'Anvers et ses Filiales et Banque Italo-Belge). In addition, no less than 23 other individual contributions of 1,000,000 francs or over were made. Another feature of the contributions was the large number of private individuals who responded. The size of such contributions naturally varied considerably, grading down to 2 francs from "Yvonne."

The general object of the Fund is to further scientific research in Belgium. It is administered by a Council consisting of representatives of Universities, Schools of Mines, medicine, veterinary science, and agriculture, together with other individuals specially co-opted. A smaller executive body or "Bureau" of the Council has also been established. In addition, executive work is carried out by a President, a Director, and a Secretary.

The revenue of the Fund may be devoted to the following purposes:—

(i) Subsidies to "savants" or to research workers, to help them to carry out their work.

(ii) Subsidies to young Belgians whose work has been brought to the attention of the Council and who desire to devote themselves to research.

(iii) Subsidies with a view to improving the equipment of existing research laboratories.

(iv) Subsidies, at the discretion of the Council, for any object which is in accord with the development of scientific research in Belgium.

East African Agricultural Research Station, Amani.

A copy of the first Annual Report (for 1928-29) of the recently re-organized East African Research Station, Amani, has recently become available in Australia. The station was originally established in 1902 by the Government of German East Africa when it was then known as the Biologisch-Landwirtschaftlichen Institut. It was taken

over by the British Forces in 1916, but for several years subsequently, comparatively little was done. The Station has, however, recently been staffed and a research programme, towards the cost of which the Empire Marketing Board is contributing, initiated.

The area of the Station is some 750 acres, of which a third remains under the original forest while a large part of the remainder is occupied by permanent plantations of trees and shrubs, collected from all parts of the Tropics and each being of economic interest. There is scarcely any land suitable for arable cultivation and the Station, in the words of its report " would be most accurately described as a well stocked arboretum."

The main buildings occupy the crown of a series of converging ridges at a height of 3,000 feet and the plantations extend down the slopes to the Sigi River at 1,300 feet and ascend a neighbouring summit to a height of 3,700 feet. The region is one of heavy rain forest of the usual mixed tropical type. The average rainfall over 29 years is 77.03 inches, with recorded extremes of 53.8 and 97.8 inches. The mean relative humidity is 84.4 per cent., the annual mean temperature 69.9° F., the mean daily maximum 76.3° F., and the minimum 61.5° F.

The programme of research includes a study of the basic types of East African soils; the collection and correlation of data regarding climate; and a study of the results of the interaction of soil and climate as expressed in the natural vegetation. Investigations are also being carried out on the growing of coffee and the breeding of coconuts, cinchona, tea, coffee, cotton and sugar cane. It is also proposed to collect and grow a wide range of plants used as fish poisons, &c., for the study of the production and use of their actual principles as insecticides. The entomologist of the Station will carry out a study of insect migration, a matter which is of no little interest in South Africa. Studies of virus diseases, and other pests and diseases of plants will also be made.

Investigations on Prickly Pear.

The Minister has recently approved of the Council continuing to contribute towards the cost of the prickly pear investigations in Queensland and in New South Wales for a further period of three years as from 1st July, 1930. These contributions are at the rate of £9,000 per annum and are made to the Commonwealth Prickly Pear Board. The other contributing parties to the Board are the Governments of Queensland and New South Wales, which contribute £4,500 each. The successful results now being obtained in Queensland as a result of the Board's introduction of insects such as *Cactoblastis cactorum* are well known.

Noogoora Burr—Biological Control.

Arrangements have been made for the continuation of the research work in progress in the United States of America on insects which attack species of *Xanthium* to which genus Noogoora burr belongs (see this Journal, Vol. 2 (1929), p. 116). For some time past, an American graduate, Mr. S. G. Kelly, has been searching in America

for likely insects. He has been working under the direction of Professor G. A. Dean, of the Entomology Department of the State College, Manhattan, Kansas. He has made satisfactory progress in his work during the summer months and has discovered certain insects which show promise of being of value in the control of *Xanthium* weed pests in Australia. Some of these insects attack the seeds and others the root and stems of the plant. They have not yet been tested, however, from the point of view of the possible damage they may cause to plants of economic value.

Other information has been received by the Council from the Royal Botanical Gardens, Kew, to the effect that in Chili, in the Argentine, and other parts of South America, *Xanthium* and certain other plants belonging to the botanical order Compositae and including the thistle, skeleton weed, &c., which are also serious pests in Australia, suffer great destruction by the ravages of numerous insects. It has therefore been arranged that Mr. Kelly will spend a period of two years on this search for insects, and that he will pay particular attention to South American countries.

The Export of Australian Apples—New Investigations.

An important matter considered by the Standing Committee on Agriculture at its meeting at the end of November, 1929, was the export of Australian apples and, to a lesser extent, pears. The Committee had before it a letter from the Empire Marketing Board enclosing a report of a special meeting held in London by representatives of certain shipping lines, of Australian and New Zealand authorities interested, and of the British Low Temperature Research Station. The Board had also furnished a memorandum by the National Federation of Fruit and Potato Trades Associations (Incorporated) Ltd. on Australian and New Zealand fruit shipments. Various recommendations and suggestions were included in the papers, but the main ones were to the effect—

(i) That the standard of inspection should be raised at certain ports, and

(ii) That it was desirable that further facilities should be made available for the precooling of fruit before export.

The matter was considered by the Standing Committee as of such importance that the State representatives present arranged for the senior officers of their Departments concerned to come to Melbourne and meet in conference a few days later to discuss the matter. Officers of the Council also attended that conference, and Mr. W. M. Carne put forward evidence in support of his belief that much of the poor condition in which some Australian shipments arrive in London ports was due to the fruit being picked at the wrong stage of maturity. Much of this evidence has been published in the Council's Bulletin No. 41 (1929). Mr. Carne is firmly of the belief that many of the apples exported are picked too soon and at such a stage of maturity that their successful carriage, with freedom from bitter pit and other storage troubles, is seriously prejudiced.

With a view to enabling growers and exporters to determine the best time of picking from a maturity point of view, he has recently correlated the results obtained by the iodine test for maturity (see

Bulletin 41) with those obtainable by the use of a colour chart. Such colour charts are now being employed in North America on a fairly large scale, and by their use it is possible to judge of the maturity of an apple for particular purposes fairly readily. The chart contains several colours ranging from green to yellowish green, against which the unblushed surface of the apple is compared. The colours are numbered, and the particular numbers corresponding to the best picking maturity of the different varieties of apples intended for export are indicated. Naturally, these numbers are not the same for all varieties, nor are the American charts of much value under Australian conditions.

As a result of the deliberations of the conference of State experts mentioned above, it has now been arranged that the Council will prepare 10,000 copies of the chart, and that these will be distributed amongst apple-exporting States for use during the coming season. It is hoped that by their use distinct improvements in the condition of the fruit when landed on the English market will result, and that in addition information on which to base further improvements in the subsequent seasons will be obtained.

Buffalo Fly Investigations.

Since the last note regarding the buffalo fly investigations of the Council was issued (see Vol. 2 (1929), p. 184), some further developments have taken place.

Mr. T. G. Campbell, the investigator who has been in North Australia for nearly twelve months in connexion with the problem, is now located at Wyndham. As the result of arrangements kindly made by Mr. L. McGhie, of the Wyndham Meat Works, he has been provided with a small laboratory at the works. He will remain at Wyndham during the rainy season, when travel is impossible, and will continue his studies of the various stages of the life cycle of the fly.

The number of investigators engaged on the problem has also been augmented by the appointment of Professor Handschin, a Swiss entomologist of repute. Professor Handschin will leave Europe in July, 1930, and will proceed to Java, where he will direct the work on the search for parasites in that place already initiated by Mr. G. L. Windred. It has previously been indicated that, while the buffalo fly exists in Java, it is not a pest in that place, and accordingly is probably being kept in control by parasites.

New Imperial Agricultural Research Bureaux—Australian Correspondents.

The following have been appointed as official correspondents in Australia to the new Imperial Agricultural Research Bureaux recently set up in England as the result of the deliberations of the 1927 Imperial Agricultural Research Conference:—

Bureau of Animal Nutrition—Professor T. Brailsford Robertson.

Bureau of Animal Genetics—Dr. J. A. Gilruth.

Bureau of Fruit Production—Dr. B. T. Dickson, with Mr. W. M. Carne as Deputy.

Bureau of Soil Science—Professor J. A. Prescott.

Bureau of Plant Genetics (Herbage Plants)—Dr. B. T. Dickson.

Bureau of Agricultural Parasitology—Dr. I. Clunies Ross.

Bureau of Animal Health—No appointment as yet.

Bureau of Plant Genetics (Plants other than Herbage)—Dr. B. T. Dickson.

Experiments on the Control of Ragwort—Proposed Liberation of Cinnabar Moth (Tyria Jacobaeae).

Prior to his departure from New Zealand, Dr. Tillyard was responsible for the initiation of experimental work with the introduced cinnabar moth (*Tyria jacobaeae*) from the point of view of its possible use in the control of the ragwort pest in New Zealand. An exhaustive series of tests since carried out in New Zealand has shown that this insect causes very great destruction to ragwort and at the same time is harmless to economic plants. A short time ago, about 500,000 specimens of the insect were liberated in ragwort-infested areas in the Bay of Plenty, Kingstown country, Taranaki, Southland, and the Nelson districts. Reports indicate that it has apparently become successfully established where liberated.

In August, 1929, pupae of the moth were imported into Australia and a stock bred up in the quarantine insectaries of the Division of Economic Entomology at Canberra. Since then, the insects have been subjected to starvation tests on Australian flora, including species *Acacia* and *Eucalyptus*. In each case the results were negative, the insects giving no indication whatever that they would attack the plant on which they were put. A permit for release has now been obtained, and it is probable it will be made in an area in Tasmania at an early date.

Tyria jacobaeae is a common species in England and parts of the Continent of Europe. It occurs wherever ragwort (*Senecio jacobaeae*) is found, its larvae feeding on this plant, and also less commonly on groundsel (*Senecio vulgaris*). Normally, it is single-brooded, though in favorable summers in England, and also towards the southern limits of its range, it may become partially double-brooded. The insect hibernates in the pupal stage in a loose web or silk spun in crannies of the soil or under leaves, or in debris, &c. The moth emerges in June (in Europe) and lives in the adult stage only about three weeks. It is very inert, sitting about and displaying its striking colours on the ragwort plant. The colouring of the insect is an example of "warning colouration," and it is notoriously distasteful to birds. The fore-wings are slate grey with an elongated red bar and spots. The hind wings are bright cinnabar crimson. The body is ringed with yellow and black.

The larvae are extremely noticeable owing to their brilliant colouration, and have been collected and reared by thousands of entomologists for more than 100 years, but there is no record of their having been found on any other plants than ragwort and groundsel.

Recent and Forthcoming Publications of the Council.

Recent publications of the Council have been—

Pamphlet No. 14.—" The Work of the Division of Economic Botany for the year 1927-28" by B. T. Dickson, B.A., Ph.D., Chief of the Division.

Pamphlet No. 15.—" The Work of the Division of Economic Entomology for the year 1927-28" by R. J. Tillyard, M.A., Sc.D., D.Sc., F.R.S., Chief of the Division.

Pamphlet No. 16.—" The Work of the Division of Animal Nutrition for the year 1928-29" by Professor T. Brailsford Robertson, Ph.D., D.Sc., Chief of the Division.

The publications which are now in the press or which will be issued shortly are as follows:—

Bulletin No. 44.—" Investigations on Spotted Wilt of Tomatoes" by G. K. Samuel, M.Sc., J. G. Bald, B.Agr. Sc., and H. A. Pittman, B.Sc.Agr.

Pamphlet No. 17.—" The Mineral Content of Pastures—Progress Report on Co-operative Investigations at the Waite Agricultural Research Institute."

Other publications by officers of the Council—

" Some aspects of the work of the Division of Animal Nutrition."—From a recent address by Professor Brailsford Robertson to the Victorian State Committee of the Council. The *Pastoral Review* (Melbourne), December, 1929, p. 1164, *et seq.*

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